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Kensington Gold Project

FINAL ENVIRONMENTAL IMPACT STATEMENT

VOLUME I

Cooperating
Agencies

EPA

Prepared for the
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ACZ

Kensington Gold Project

Final Environmental Impact Statement

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Lead Federal Agency ______ USDA Forest Service
Tongass National Forest
Chatham Area

Responsible Official ______ Gary Morrison
Forest Supervisor

Cooperating Agencies ______ US Environmental Protection Agency
US Army Corps of Engineers

Contact ______ Roger Birk
Juneau Ranger District
8465 Old Dairy Road
Juneau, Alaska

This Final Environmental Impact Statement is written in response to a proposal for an underground gold mine on the Tongass National Forest. The Forest Service will use this document to support a decision on a plan of operations under 36 CFR 228. The FEIS will also support decisions by the U.S. Army Corps of Engineers and The Environmental Protection Agency for permits under Sections 404 and 402 of the Clean Water Act. The proposal is to mine 4,000 tons of ore per day for a period of 12 years. Tailings would be disposed in a conventional tailings impoundment located in Sherman Creek basin. The site would be reclaimed after mining is complete. Approximately 340 people would be employed. There would be an onsite camp for workers who would commute to the site via helicopter.

Alternatives to the proposed action that were considered include: 1) not developing the project; 2) changing the location of several project features, 3) having employees commute to the site every day, 4) moving some of the project features to underground mine excavations, 5) disposing of the tailings in a dewatered tailings facility and 6) using different wastewater treatment strategies and different locations for project effluent discharge.

SUMMARY

INTRODUCTION

The Kensington Venture has submitted a project proposal to the USDA Forest Service, Tongass National Forest, Chatham Area, for proposed development and operation of the Kensington Project. The proposed Kensington Project consists of an underground gold mine, an ore processing facility, an office and maintenance complex, an employee camp, heliport, a marine terminal, an explosives magazine, and miscellaneous support areas. The Kensington Project is a joint venture between Coeur Alaska Inc. (a subsidiary of Coeur d'Alene Mines Corporation) and Echo Bay Exploration, Inc. (a subsidiary of Echo Bay Mines Ltd.). The project site is located on the west side of the Kakuhan Range adjacent to Lynn Canal, approximately 45 air miles north of Juneau and 35 air miles south of Haines, Alaska.

The Forest Service has determined that a decision on the proposal would be a major federal action requiring the preparation of an Environmental Impact Statement (EIS) under the National Environmental Policy Act (NEPA). NEPA regulations and guidelines are issued by the Council on Environmental Quality (CEQ); each federal agency is responsible for developing its own regulations and guidelines for compliance with NEPA. This EIS has been prepared by the Forest Service in accordance with applicable CEQ and Forest Service regulations and guidelines and in cooperation with the EPA and US Army Corps of Engineers.

This summary briefly describes the contents of the EIS as follows:

Chapter 1 - Purpose of and Need for Action: Describes the project as proposed by the Kensington Venture, discusses the need for the EIS and other Federal, State, and local permits, and identifies issues raised during the scoping process and addressed by this analysis.

Chapter 2 - Alternatives Including the Proposed Action: Describes how the alternatives were developed, discusses the proposal offered by the Kensington Venture and describes the other alternatives chosen for consideration. It compares alternatives on the basis of their environmental effects.

Chapter 3 - Affected Environment: Describes the physical and biological environment and socioeconomic conditions that would be affected by the alternatives.

Chapter 4 - Environmental Consequences: Describes the potential environmental consequences of all alternatives.

This summary provides a condensation of the EIS and includes important information from each section of the document. The FEIS, rather than the summary, provides detailed information. Beyond the information in the FEIS, additional documentation of the environmental analysis is contained in the planning record, which is available for public inspection at the Juneau Ranger District office.

CHAPTER 1 - PURPOSE OF AND NEED FOR ACTION

The purpose of and need for the proposed action is to develop and operate an underground gold mine within the Kensington Venture's claims boundary. The proposed project is consistent with the General Mining Law of 1872 and its principal amendment of July 23, 1955.

The proposed Kensington Project consists of an underground gold mine, mill and associated facilities which would be located on public and private land. The mine has an expected life of 12 years and would produce about 4,000 tons of ore and 400 tons of underground development waste rock per day. The work force is anticipated to be 340 people during full production.

Several laws impact and influence the conduct of mining operations on public lands such as the Tongass National Forest. Under the 1872 General Mining Law, qualified prospectors may search for mineral deposits on public lands designated as available for mineral entry. Subsequent laws such as the Mining and Mineral Policy Act and the Federal Land Policy and Management Act have imposed conditions

on how these activities may be conducted. NEPA procedures ensure that environmental information is available to public officials and citizens before decisions are made and before actions are taken. The responsible Federal agency Is required to review the Applicant's Plan of Operations to ensure that:

1) Adequate provisions are included to minimize, where feasible, adverse environmental impacts on public land resources.

2) Measures are included to provide for reclamatlon, where practicable.

3) The proposed operation will comply with other applicable Federal and State laws and regulations.

The Forest Supervisor for the Chatham Area of the Tongass National Forest is the Responsible Official for this decision. Based on the analysis provided in the EIS, he may select one of the alternatives discussed herein, select an alternative that combines features of more than one alternative, or select an alternative that includes additional mitigation measures.

To assist in identifying issues and concerns related to the Kensington Project, the Forest Service held three public scoping meetings. One was held on December 13, 1989, in Juneau. Two meetings were held in Haines on January 9, 1990, and on May 10, 1990. Following issuance of the DEIS, the Forest Service continued to take public input. The period for written comments began June 1, 1991, was open 94 days to September 3, 1991. During this period two public hearings were held; one on July 12, 1991 in Juneau's Centennial Hall, and one on July 19, 1991 at the Chilkat Center, Haines. Two day-long water quality workshops were also held; August 8, 1991 in Haines and August 9, 1991 in Juneau.

Significant issues were identified in these broad areas:

- **Socioeconomics.** Address the impacts on the local residents in Juneau, Haines and Skagway.

- **Fisheries.** Maintain quality of existing fish habitats and minimize impacts to resident and anadromous fish which support an important commercial fisheries industry in Lynn Canal.

- **Marine Transportation.** Minimize disruption to marine traffic in Lynn Canal, especially commercial fishing.

- **Water Quality.** Maintain the integrity of affected watersheds by minimizing impacts to water quality and maintaining proper flows. Maintain water quality in Lynn Canal.

- **Recreation.** Minimize disruption to recreation opportunities.

- **Visibility/Air Quality.** Minimize visual impacts of the operation from Lynn Canal and Berners Bay.

- **Land Use/Reclamation.** Minimize disturbance in the LUD II area by maintaining a compact operation.

- **Wildlife.** Minimize disruption to wildlife and wildlife habitats.

- **Subsistence.** Identify subsistence resources and level of use within the project area.

- **Cumulative Impacts.** Address the cumulative impacts of this and other potential development projects.

- **Technical Feasibility.** Minimize chances of system failure by incorporating technically feasible component siting, design, and mitigating features.

- **Economic Feasibility** Component design should be cost effective.

Within each of these categories, concerns and questions were identified and documented for further analysis. In this way, information collection, formulation of alternatives, and predictions of environmental effects are based on the most important and relevant issues and concerns.

Other activities in tourism, commercial fishing, recreation and mineral development are occurring or proposed in the region surrounding the Kensington Project. Mineral resource activities mostly are focused on exploration but some development and mining is occurring. Large cruise ships and individuals use Lynn Canal and Berners Bay. Commercial fishing occurs throughout Lynn Canal.

Compliance with other laws is normally guaranteed through a separate permitting process which would commence after a preferred alternative is selected and approved. For the Kensington Project, permits or approvals are required from the following agencies:

Federal
- Forest Service
- Environmental Protection Agency
- Army Corps of Engineers
- Fish and Wildlife Service
- National Marine Fisheries Service
- Coast Guard
- Federal Aviation Administration
- Federal Communications Commission
- Bureau of Alcohol, Tobacco, and Firearms
- Mine Safety and Health Administration

State of Alaska
- Division of Governmental Coordination
- Department of Environmental Conservation
- Department of Natural Resources
- Department of Fish and Game

City and Borough of Juneau

CHAPTER 2 - ALTERNATIVES INCLUDING PROPOSED ACTION

The Forest Service is required by NEPA to consider alternatives to the proposed action which address important issues identified in the scoping process. Alternatives are developed in a sequenced process. First, the project is segregated into major components. Options for design, location, and operation for each major component are identified. Options are then individually screened for their ability to address key issues. Those options surviving the screening process are then combined into reasonable alternatives for detailed consideration in the EIS. The following component options are carried forward for detailed consideration:

- **Mining Methods.** (1 option) Long hole, open stoping underground mining.
- **Waste Rock Disposal.** (2 options) Temporary stockpiling for construction uses, permanent disposal.
- **Crushing.** (1 option) Located in underground excavations.
- **Grinding.** (2 options) Surface and underground locations.
- **Cyanidation.** (1 option) Surface tank cyanidation and carbon adsorption.
- **Processing Ore and Concentrate.** (1 option) Processing at the site.
- **Refining.** (1 option) Onsite, shipment via helicopter.
- **Cyanide Destruction.** (2 options) Alkaline chlorination and hydrogen peroxide.
- **Wastewater Treatment for Metals an Suspended Solids.** (4 options) Settling in tailings pond, enhanced settling and tailings pond management, enhanced settling and tailings pond management with filtration of the effluent stream, and enhanced settling and tailings pond management with chemical precipitation and clarification of leach circuit tailings stream.
- **Marine Discharge.** (2 options) Locations both north and south of Point Sherman are studied. Effects of discharge at 50 m depth and 100 m depth.
- **Tailings Disposal.** (3 options) Conventional dam (Sherman/Sweeny creeks); dewatered tailings disposal (upland in Sherman Creek drainage or upland near beach).
- **Housing.** (2 options) Onsite employee workcamp (Sherman Creek); daily commute, Auke Bay to Slate Creek Cove (ferry and bus).

- **Water Supply.** (1 option) Combination surface and ground water.
- **Fuel Storage.** (1 option) Above ground LPG and diesel.
- **Waste Disposal.** (1 option) Incineration and barging with offsite disposal of hazardous wastes.
- **Sewage disposal.** (1 option) Package treatment plant (discharge treated sewage effluent via near shore and deep water options).
- **Rock Quarry.** (4 options) Alternate sites for various alternatives.
- **Joint Facilities.** Considered for all project components except the mine.
- **Generator Location.** (2 options) Comet Beach and near the mill facilities.

The following component options were evaluated but eliminated from detailed consideration:

- **Mining Methods.** (2 options) Cut and fill mining: open pit mining.
- **Crushing.** (1 option) Surface location.
- **Cyanidation.** (3 options) Underground location, heap leaching, vat leaching.
- **Processing Ore and Concentrate.** (3 options) Offsite concentration, offsite cyanidation of concentrates, and offsite smelting of concentrates.
- **Cyanide Destruction.** (7 options) SO_2/Air, Biological, Ferrous Sulfide, Acidification/Regeneration, UV Ozone, Ion Exchange and Ferrous Sulfate.
- **Wastewater Treatment for Metals and Suspended Solids.** (9 options) Three different chemical precipitation processes, Reverse Osmosis, Electrodialysis, Ion Exchange, Granular Activated Carbon, Evaporation/Crystallization/Distillation and Electrolytic.
- **Tailings Disposal.** (5 options) Slate Creek Lakes, Independence Lake, complete mine backfill, partial mine backfill, and submarine tailings disposal.
- **Marine Discharge.** (1 option) No mixing zone.
- **Housing.** (2 options) Daily commute by ferry (Echo Cove to Slate Creek Cove), satellite community.
- **Transportation.** (3 options) Float plane, wheeled fixed wing plane and road transport.
- **Power Supply.** (2 options) Long term diesel fuel and reciprocating drivers for generators, hydropower.

Following is a summary of the complete project alternatives assembled from the component options studied in detail.

ALTERNATIVE A - NO ACTION

NEPA requires that a No Action alternative be considered in all environmental documents. This alternative serves as a reference point for describing the effects of the other alternatives.

Under this alternative, the Forest Service would not approve the Plan of Operations for the Kensington Gold Project. This alternative precludes any mining and milling activities as currently proposed, on National Forest land at the project site.

ALTERNATIVE B - APPLICANT PROPOSAL

This alternative would consist of an underground mine, an ore processing facility, tailings impoundment, an office and maintenance complex, an onsite employee camp, heliports, a Comet Beach marine terminal, and miscellaneous other support facilities such as a fuels storage area and an explosives magazine. The total disturbed area is estimated to be 275 acres.

The Kensington Project has an estimated life of 12 years. During full production, the project would process approximately 4,000 tons of ore per day. The mill would use conventional

milling techniques: flotation followed by standard tank cyanidation methods to produce gold bullion. Approximately 400 tons per day of underground development waste rock would be hauled to the surface for construction of a cross valley tailings pond embankment in Sherman Creek. The waste rock would also be used in constructing road bases and facility foundations. Wastewater treatment would be by alkaline chlorination and basic pond settling. The Ophir Creek diversion spillway would be concrete lined. Two LPG fired generators would be located at the mill site.

Approximately 340 people would be employed during full production. At least half of these employees would be onsite at any one time. An employee camp would be constructed onsite to house workers. Employees would be transported to the site by helicopter. Supplies and fuel would be transported by barge to a marine terminal at Comet Beach.

ALTERNATIVE C - BERNERS BAY ACCESS

Under this alternative, many of the project components would remain as proposed under Alternative B. The following items would be different: 1) the marine terminal would be located at Slate Creek Cove in Berners Bay; 2) employees would commute to the Project daily by ferry; 3) employees would not live at the onsite camp during their work schedules; 4) borrow areas for construction would disturb an additional 3 acres; 5) the stream channel diversion would be a riprap lined channel rather than a concrete spillway; and 6) wastewater treatment would include enhanced pond settling in addition to the treatment described in Alternative B. Total area projected to be disturbed by this alternative is 392 acres. Much of the increased disturbance would be from the access road between the marine terminal and the mine site.

ALTERNATIVE D - SWEENY CREEK TAILINGS

Under this alternative, many of the project components would remain as proposed under Alternative B. Following is a description of the items that would be different. Grinding equipment would be located underground. Ground ore would be transported via pipeline to surface facilities for metal extraction. LPG turbine generators would be located near Comet Beach rather than at the process area. Tailings from the milling process would be placed into a cross valley tailings impoundment constructed in the Sweeny Creek drainage. A 2-mile slurry pipeline and road would be required from the mill to Sweeny Creek. Employees would be transported to the site with helicopters that would leave from a heliport near the Yankee/Bridget Cove area. Two LPG fired turbines would be located near Comet Beach. There would be excess waste rock requiring a permanent disposal site for over 600,000 tons of material. The estimated total disturbance area is 229 acres.

ALTERNATIVE E - DEWATERED TAILINGS

Under this alternative, many of the project components would remain as proposed under Alternative B. Following is a description of the items that would be different. Mill tailings would be disposed in a dry (unsaturated) pile located in one of two upland locations. One location option (site A) is located north of Sherman Creek and west of Ophir Creek. Site B is on the moderate slope area adjacent to Lynn Canal between Sherman and Sweeny creeks. This tailings configuration would require filter and thermal drying equipment to produce a dewatered tailings product with about 14 percent moisture content. A third generator (located at the mill site) would drive the drying process. Hydrogen peroxide would be used to destroy cyanide. Overall area of disturbance for the project under this alternative would be about 242 acres (site A) or 237 acres (site B).

ALTERNATIVE F-ENHANCED EFFLUENT TREATMENT

Under this alternative, many of the project components would remain as proposed under Alternative B. Following is a description of the items that would be different. Water treatment at levels above those proposed by the applicant would be implemented. Three options are included. 1) Addition of flocculants to the mill wastewater stream and use of baffles and water level management in the tailings pond to promote settling. 2) The measures described in 1 plus filtration of the tailings pond effluent prior to discharge. 3) The measures described in 1

plus chemical precipitation and clarification of leach circuit tailings stream; this third option also uses hydrogen peroxide to destroy cyanide.

MANAGEMENT, MITIGATION, AND MONITORING

Environmental management and mitigation constraints are designed to ensure that environmental impacts are minimized during construction and operation of the Kensington Project. Monitoring programs would determine the environmental changes that may result from implementation of the project and evaluate the effectiveness of mitigation measures. Mitigation, monitoring and reclamation requirements identified in the EIS are part of the basis for discussion of environmental consequences. Requirements identified in the preferred alternative represent the minimum required for project permits. These measures are usually adopted in the form of stipulations attached to permits issued by the various regulatory agencies identified in Chapter 1.

Project constraints, permitting requirements, and other management requirements are discussed in this section. These requirements may vary from alternative to alternative and are considered in predicting environmental consequences. Examples of some of the measures proposed in the various alternatives to minimize environmental effects are as follows:

- Helicopter Transportation of Employees -- flight path of the helicopter would avoid routes which disturb species such as mountain goats and bald eagles.

- Lynn Canal Access/Transport -- scheduling of barge traffic to Kensington around commercial fish openings would mitigate impacts to commercial fishing.

- Onsite Employee Camp -- implementation of a "no guns" and "no trapping" policy for anyone working and living onsite.

- Water Quantity/Water Quality -- runoff would be diverted around disturbed areas. Surface water and ground water quality would be monitored on a regular schedule.

The Forest Service has identified mitigation measures that would be implemented if any of the action alternatives are adopted. The mitigation measures cover the following resource areas:

- Land Use
- Water Quantity and Quality
- Fish and Wildlife
- Recreation, Visibility and Public Access
- Air Quality
- Socioeconomics

Monitoring measures have been developed for implementation if an action alternative is adopted. The monitoring measures are designed to target specific objectives and cover the following areas:

- Water
- Aquatic resources
- Wildlife
- Timber
- Visual quality
- Geotechnical stability

IDENTIFICATION OF THE PREFERRED ALTERNATIVE

The Forest Service will identify the preferred alternative in the Record of Decision.

COMPARISON OF ALTERNATIVES

The alternatives for the Kensington Project have been compared and evaluated based on the issues determined as part of the scoping process. Significant issues were used to compare effects of project alternatives.

CHAPTER 3 - AFFECTED ENVIRONMENT

The following sections describe existing environmental resources in the study area which may be affected by implementation of an action alternative.

AIR QUALITY & CLIMATE

Air quality in the vicinity of the Kensington Project is expected to be very good. The

absence of nearby pollutant sources combined with abundant rainfall suggest that existing background pollutant concentrations are small.

The climate Is maritime, influenced by currents in the Pacific Ocean which prevent temperature extremes from being common. Average annual preclpitation at the project site Is estimated to range from 60 to 110 inches In the Sherman, Sweeny, and Slate Creek drainages. Rainfall occurs on 180 or more days each year. The maximum estimated 24-hour precipitation at the site is 5.64 inches.

Meteorological data have been collected at the project site from February 1989 through February 1990. WInds blow predominantly from the east and east-southeast in alignment with the Sherman Creek drainage. The average wind speed at the site is 3.7 miles per hour and high wind episodes are rare. Atmospheric clarity, measured by visual range, Is small at the Kensington Project site. Clouds and water vapor typically restrict the visual range to 26 miles.

TOPOGRAPHY

The proposed Kensington site is within the Sherman Creek drainage at the western foot of Lions Head Mountain in the Kakuhan Range on the coastal mountains. The Kakuhan Range is a north-northwest trending mountain range composed almost entirely of massive cliff forming rocks. Lions Head Mountain rises to an elevation of almost 5,000 feet above sea level. Drainages in the area are steep and are characterized by smooth, frequently dissected, shallowly incised mountain slopes with gradients steeper than 75 percent.

GEOLOGY

The Kensington ore zone is found in the north end of the Juneau Gold Belt. Two major faults trend northwest-southeast through the mine area. The Kensington vein system generally trends north-south and is composed primarily of quartz; pyrite and chalcopyrite are the only sulfide minerals. The gold content is directly related to the volume of quartz and pyrite.

Glacial processes have formed the Sherman Creek valley. The valley has a thin surficial vegetative mat underlain by silty clay tills ranging up to 180 feet in thickness. The till in the project area is divided into two major units which are generally hard, dense, and over consolidated.

GEOTECHNICAL CONSIDERATIONS

The Kensington Project site is located within an area traversed by major regional faults having a history of earthquake activity. The Fairweather Fault, located approximately 70 miles west of the project, was the location of a magnitude 8.0 earthquake In 1899 and a magnitude 7.7 earthquake in 1958. The Chatham Strait fault has been mapped offshore of the project in Lynn Canal and appears to be a branch of the Queen Charlotte Island fault which experienced earthquakes of magnitude 8.1 and 7.7 in 1949 and 1972, respectively. Earthquake damage potential in this area is considered moderate.

Seismic risks at the site include slumping, landslides, and tsunamis. Debris slide and slope stability hazard analyses indicates that slope conditions in the vicinity of Sherman Creek mill and portal are relatively stable despite the steep slope conditions. Other geotechnical considerations include steep slopes above the project site. These steep slope areas are susceptible to landslides, mass wasting and avalanche.

SURFACE WATER HYDROLOGY

Watersheds in the site vicinity include Sherman Creek, Sweeny Creek, and Slate Creek. These drainages are all perennial and terminate at tidewater. The streams are primarily gaining throughout the reaches of the project. Characteristics regarding soil, vegetation, and climate were investigated for each watershed.

Results of storm event modeling show that the Sweeny and Slate Creek drainages generate less runoff per acre of watershed than Sherman Creek due to the flatter slopes and the lack of significant amounts of rock outcrops and snow fields at higher elevations.

Range of flow for Sherman Creek has been between 0.48 and 203 cfs. Range of flow for Sweeny Creeks has been between 0 and 241 cfs.

Surface water quality data for the Sherman Creek drainage were obtained from four monitoring stations. Sherman Creek water is of calcium bicarbonate sulfate type with low alkalinity and hardness. Total dissolved solids (TDS) ranged from 16 to 194 mg/l with a median value of 55 mg/l. The pH ranged from 6.0 to 7.8 with a median value of 7.3. The surface water in Sweeny Creek is similar to the Sherman Creek water but with a lower dissolved solids content. Trace metals content is generally below laboratory detection limits.

There are no water rights in the project area other than those applied for by the Kensington Venture. Water rights for the project would be for surface water and groundwater wells that would be established and maintained for the life of the project.

GROUND WATER HYDROLOGY

Historically, water inflow into mines in southeastern Alaska have hampered mining efforts. Ground water at the Kensington Project site has been characterized for the underground workings, the mill and tailings site in the Sherman Creek drainage, and the alternative tailings site in Sweeny Creek drainage.

Present mine water discharge from the underground exploration workings ranges from 100 to 400 gallons per minute. The majority of the water enters the workings along a fracture system oriented northwest-southeast within the mine. Water discharges rapidly into the mine at the time of drilling or opening a new stope, but inflow decreases rapidly over time.

Water quality has been monitored during exploration operations in the underground workings and indicates that the water is a calcium-sulfate type with bicarbonate increasing with depth. The pH values range from 7.0 to 8.0. Total Dissolved Solids (TDS) values range from 46 to 102 mg/l with a decrease in dissolved solids occurring with depth. Trace metals content is typically below laboratory detection limit.

Three hydrogeologic units are encountered in the Sherman Creek drainage: alluvial and terrace sands and gravels, glacial till, and phyllite bedrock. Within the three hydrogeologic units, perched and saturated zones were encountered during drilling.

The primary aquifer recharge mechanism is from direct infiltration of precipitation and snowmelt. Recharge of the aquifers is estimated at 15 to 20 percent of the average annual precipitation. The rate of groundwater recharge is reduced by seasonal freezing of soils.

Groundwater in the Sherman Creek drainage is of bicarbonate, calcium type with TDS ranging from 21 to 479 mg/l. The pH ranges from 6.0 to 9.9.

The hydrogeology of Sweeny Creek appears to be similar to Sherman Creek. Glacial till and bedrock are the main water bearing strata in this drainage.

Ground water in the Sweeny Creek drainage is assumed to be of bicarbonate, calcium sulfate type with low total dissolved solids and a pH slightly above neutral.

AQUATIC RESOURCES

Marine oceanographic field surveys were conducted in Lynn Canal near the project facilities to delineate areal distribution and seasonal patterns in the chemical constituents and physical properties of the water column. Studies were conducted on the chemical composition, physical properties, and bathymetry of the sea bottom.

Seismic studies indicate that Lynn Canal is a deep U-shaped trench (950+ feet) with over 80 feet of soft mud on the bottom. The nearshore seafloor appears to include common rock outcrops, ledges, and slopes. Nearshore sediment samples indicate high suspended sediment load from glacial drainage in these areas.

Fresh water input, tidal exchange and winds are the dominant forces affecting circulation in Lynn Canal. Circulation is sufficient for frequent flushing of the canal.

Lynn Canal and Berners Bay support a variety of shellfish. Until recently, the population of Tanner Crabs in Lynn Canal supported a

significant fishery. Harvesting has declined over the past 5 years due to parasitic infestation.

Shrimp and crab pots were deployed in nearshore areas near the mouth of Sherman Creek at depths ranging from 30 to 156 feet. A variety of demersal fish, invertebrates, and a few small Tanner crabs were collected in the shrimp pots. Species collected in the crab pots were sea stars, decorator crabs, and green urchins.

Surveys conducted in the intertidal and subtidal zones of Lynn Canal discovered marine snails, acorn barnacles, blue mussels, blennies, green sea urchins, and marine worms. The majority of the fauna was found on rock outcrops as opposed to the cobbly substrate.

Subtidal habitats were dominated by the green sea urchin, hermit crabs, and sea stars. Much of the subtidal substrate, at depths of 5 to 35 feet, is similar in composition to the intertidal zone and is comprised of smooth cobbles and bedrock outcroppings. Below 35 feet, the bottom consists of mixed sediments of fine silt, coarse sand, and gravel.

Numerous marine fish species inhabit Lynn Canal and Berners Bay. The major ones include Pacific herring, Pacific cod, sablefish, Pacific halibut, arrowtooth flounder, flathead sole, and skate species. Pacific herring are known to spawn in Lynn Canal. Adult sablefish utilize lower Lynn Canal for summer feeding, though this area is apparently on the fringe of the more heavily used feeding from Chatham Strait.

Anadromous species that occur in significant numbers in Lynn Canal-Berners Bay waters include chinook, sockeye, coho, pink, and chum salmon as well as Dolly Varden char, cutthroat trout, steelhead, and eulachon. The major production areas of these species are the Chilkat and Chilkoot rivers at the head of Lynn Canal and the Berners River.

The Berners River is ranked among the top producing coho rivers in Southeast Alaska. Current levels of chinook production in Lynn Canal rivers are low. Lynn Canal and Berners Bay serve as both rearing areas and migration pathways for juvenile salmonid species. Coho salmon juveniles emigrate from freshwater at ages of 1 to 4 years with peak migration occurring after the peak of the pink and chum emigration.

Adult salmon return through upper Lynn Canal from mid-June to mid-October. The movement of adult salmon through upper Lynn Canal appears to be primarily along the eastern shore.

Lynn Canal supports major commercial fisheries with salmon being the most notable. The commercial salmon fishery in upper Lynn Canal is active from mid June into early October. Fishing is by drift gillnets and trolling techniques. Other commercial fisheries occur for groundfish, crab, and shrimp.

Much of the fishing activity in upper Lynn Canal occurs near the project area and is centered around Point Sherman. Where water depth is sufficient to accommodate nets, fishing occurs close to shore.

The two streams directly associated with project alternatives are Sherman and Sweeny creeks. Both streams support anadromous and resident fish populations. Pink salmon spawn in Sherman Creek.

Salmonid rearing habitat is limited in lower Sweeny Creek due to lack of pools and instream cover. Spawning gravels occur in small, widely scattered patches. Dolly Varden char, cutthroat trout, sculpin, and pink salmon are found in these areas.

SOILS/VEGETATION/WETLANDS

The soils of the study area have been strongly influenced by an extensive history of glaciation that has occurred throughout Southeast Alaska. As a result, all of the soils are very young with respect to the normal processes of soil formation. Climatic conditions, such as the high levels of precipitation, create considerable organic matter and favor the development of organic soils. Peat deposits ranging from 2 to 40 feet in thickness are found in the area.

On a regional scale, the soils of the study area are characterized as very porous and friable, and extremely acidic, except in the lowest horizons that overlie calcareous bedrock. Water holding capacity for these soils is very high and

soil moisture is ample for tree growth. The wetness of soils can cause problems with cut slope failure and limits the suitability of many of these soils for road construction. The organic soils rate poorly for reclamation suitability.

The vegetation of southeastern Alaska has been described as a coastal rain forest due to the proliferation of plant growth. The dominant vegetation type is a coniferous forest which occurs over a broad range of upland slopes and aspects. The habitat is characterized by an overstory dominated primarily by Western Hemlock at the lower elevations and Mountain Hemlock in the higher elevations with Sitka Spruce throughout. Understory shrubs are Alaska blueberry, rusty menziesia, Devil's club and salmonberry.

Deciduous forest is the least extensive upland habitat within the study area, occurring only as small pockets near the beach fringe and moist areas. Alder shrubland occurs primarily in avalanche chutes and as small pockets along drainages.

Wetland communities represented are muskeg/open shore pine forest, wet conifer, and sedge/grass/forb meadow. The wet conifer forest is the most prevalent, often forming a mosaic of forested habitats with conifer forest. Standing or flowing water is often present throughout the wet conifer forest.

Muskeg, consisting of open, open forested, and forested areas, is the second most extensive wetland habitat. In the open treeless muskeg where small pools of water are relatively common, herbaceous species, mosses, and lichens predominate. Open forested muskeg supports small stands of stunted lodgepole or shore pine, western hemlock, and Sitka spruce with an understory composed of various alder and berry bushes. The forested portions of the Muskeg support a dense understory of alder and berry bushes.

Sedge/grass/forb meadows occur in small pockets adjacent to open water and in narrow strips along portions of the beach fringe. These areas are dominated by sedges, horsetails, and reedgrass.

WILDLIFE

Site specific field studies, regional published information and agency file data were reviewed to obtain information on the wildlife resources of the project area. Several key species are of special concern due to their expected sensitivity to development of the Kensington Project. These species are: black bear, brown bear, gray wolf, mountain goat, bald eagle, and Vancouver Canada goose.

Black bear are relatively common in the area and are known to use habitats along the coast in the Sherman Creek drainage and mountain slopes above the project area. Brown bear may occasionally occur near the project area but are not expected to be common since black bears are usually not prevalent in areas supporting brown bears.

Gray wolves are known to occur infrequently in the Sherman Creek drainage but are more common near the Slate Creek and Berners River drainages.

A population of 60 to 80 mountain goats occupy suitable habitats surrounding Lions Head Mountain. Their distribution is closely tied to steep terrain with areas of rock outcrop.

Eagle nest sites near the project area are closely correlated to old-growth forest near the coast. Salmon runs in local creeks during the summer represent an important food source for resident eagles.

Vancouver Canada geese prefer to nest in beach fringe areas near water in the project region. The greatest numbers of Vancouver Canada geese were noted in the Slate Creek Lakes area, but no nesting use was documented in this area.

Two endangered species, American peregrine falcon and humpback whale, and one threatened species, Steller sea lion, are known to occur within the region of the project area. No known critical habitat for any state or federally listed threatened or endangered species occurs within the project area.

RECREATION

Recreational opportunities in the study area are divided into two main categories: resident and non-resident (tourists). The tourism industry in the area is shaped primarily by the remote location and lack of overland transportation to much of the Tongass National Forest. Tourist activities are primarily related to wildlife resources and the outstanding visual character of the area. Wildlife viewing, and sightseeing from aircraft and boats, bring tourists from nearby Juneau into direct contact with the project area.

Residents of southeast Alaska make up 2.2 of the 2.8 million visitor days that occurred in the Tongass National Forest in recent years. Most of the recreational use occurs along shorelines, lakes, and rivers. The primary recreational activities that could potentially be affected by the project are water based recreation, dispersed camping associated with boating, non-subsistence hunting and fishing, recreational cabin use and visitors to Point Bridget State Park.

The Berners Bay area is a popular water recreation and sport hunting area for Juneau residents. Black bear, brown bear, mountain goat, and moose are the most frequently hunted big game.

CULTURAL RESOURCES

Earliest recognized occupation in the project region has been dated at 10,200 years ago. Beginning about 5,500 years ago, occupation sites arose along the immediate coast near the mouths of productive fish streams.

Berners Bay is known for at least three permanent Tlingit village sites and places of recorded petroglyphs. The remainder of the known cultural resources in the Kensington Project area are the historic mining sites which experienced peak activity from 1890 to 1910. At least 15 other mines once operated within a 5 mile radius of the Kensington Mine.

Of the several known and reported cultural resources around Berners Bay, only one site might be impacted by an alternative of the Kensington Project.

VISUAL RESOURCES

Visually, the study area appears as three general landscape components: the water; the lower rounded forested foothills on the canal banks and islands; and steep, often ice-clad taller peaks behind the foothills to the east and west of Lynn Canal.

The general study area is divided into two distinct viewsheds by the ridge running north from Point St. Mary. To the west is the Lynn Canal viewshed, to the east the Berners Bay viewshed. Lynn Canal is a major transportation corridor traveled by tourists and residents on routes of the Alaska Marine Highway ferries and private cruise ships. Commuter airline routes between Juneau and Skagway and Haines also follow Lynn Canal. The Berners Bay viewshed is more confined and is a recreation destination for Juneau area residents in small power boats or sea kayaks.

SOCIOECONOMIC ENVIRONMENT

The socioeconomic environment associated with the Kensington Project is characterized for 3 areas; The City and Borough of Juneau, Haines and Skagway. Demographic trends, economic indicators and capacity of jurisdictional services are discussed.

City and Borough of Juneau

The 1990 census found 26,696 people in Juneau, up 37 percent from the 1980 figure. The 1990 Alaska revenue sharing program estimate for Juneau population was 28,881.

Juneau area public schools include five elementary schools, two middle schools, and one high school. Six privately operated schools provide preschool and kindergarten through eighth grade education. The University of Alaska Southeast offers baccalaureate, professional, and master degree programs in business, fisheries, public administration, and education. The Juneau/Douglas Community College offers vocational and technical associate degree programs.

Bartlett Memorial Hospital is a 64 bed medical facility which provides emergency room treatment, in-patient, out-patient and newborn

services. In 1988, there were 40 licensed physicians, 15 dentists, eight chiropractors, three optometrists, and one naturopath in the Juneau area.

Public water supplies are obtained from the Salmon Creek Reservoir and a well field in the Last Chance Basin. Two new wells are being added in 1990 to the well field. Three waste water treatment plants service 75 to 85 percent of the area population of the City and Borough of Juneau. Solid wastes are collected and hauled to a private incinerator/landfill facility in the Lemon Creek area.

Electrical power requirements are supplied by the Alaska Electric Light and Power Company and rely on hydroelectricity to meet base demand with diesel generating facilities as backup.

In 1990, there were an estimated 10,493 dwelling units in the Juneau area of which 68 percent were single family units, 21 percent were multifamily units, and 4 percent were mobile homes. The total vacancy rate was only 1.5 percent.

The City and Borough of Juneau is serviced from the outside by air and water. Juneau International Airport provides support facilities for daily passenger and cargo jet services as well as for several air taxi operators. Waterfront facilities in Juneau include a two berth deep draft dock front, ferry terminal landing, barge unloading facilities, and four small boat harbors with a total of 900 slips.

City of Haines and Borough of Haines

The preliminary reported population estimate for 1990 was 2,115 people. The population fluctuates on a seasonal basis with increases in the summer and decreases in the winter.

The Haines Borough School District provides educational services for 365 students, kindergarten through twelfth grade, in Haines. Twenty students, kindergarten through fourth grade, are served by facilities on Mosquito Lake Road at mile 27.

The Haines Medical Center serves the medical needs of the area and is staffed by one physician with several backup part-time physicians

Public water is obtained from Lily Lake and distributed to 314 residential and 132 commercial customers. The City owns and operates a package waste water treatment plant which is capable of handling a population of 1,500 people. Solid waste is collected and disposed of at a sanitary landfill by a private contractor.

Electric power is supplied by the Haines Light & Power Company, using six diesel electric generators.

The U.S. Census Bureau reported 527 housing units in the City of Haines and 1,112 housing units in the Borough in 1990. Unofficial sources report that the available rental units do not match the demand. The Haines area includes extensive private land holdings. Much of this land is available for purchase and/or residential development.

Haines is one of the most accessible communities in Alaska, with scheduled air and ferry service as well as a road link to the Alaska Highway System.

City of Skagway

Skagway became the first incorporated city in Alaska in 1900. Today it is a first class city which governs approximately 443 square miles of land, including the town of Dyea. The 1990 reported population estimate is 692 residents. The annual reported payroll in 1989 totaled over $11 million.

The Skagway School District provides educational services to approximately 144 students, kindergarten through twelfth grade.

Health services consist of a two-bed medical clinic staffed by two physicians assistants. A private physician from Haines offers scheduled weekly visits. Other services include family practice, mental health counseling, and regular visits by the Public Health Nurse, an optometrist, and a dentist.

The City of Skagway operates the water, sewer and waste disposal services. Public water is

obtained from three wells which tap an aquifer below the Skagway River. Sewage treatment is minimal; waste is screened, then discharged into the Talya Inlet. Solid waste Is disposed in a city-owned landfill. The US Bureau of the Census counted 404 housing units in Skagway In 1990. Additional Information on housing in Skagway Is not available.

The Klondike Highway links Skagway to the Alaska Highway System and was opened year-round in 1986. Skagway is the northern terminus of the Alaska Marine Highway System. There is a community airport with a 3,750 foot paved runway and terminal, owned and operated by the State of Alaska.

SUBSISTENCE

Subsistence refers to the customary and traditional uses of fish and game and other renewable natural resources by rural Alaskan residents. The harvest and use of subsistence resources are important to rural Alaska residents because they are less expensive and often nutritionally superior to store purchased products. Subsistence resources can supplement or partially replace income from wage employment. The harvest, use, and redistribution of subsistence resources is considered an Integral part of the culture and value system of many rural and indigenous Alaskans.

Important marine subsistence resources include five species of salmon as well as shellfish and crab. Terrestrial subsistence species include two species of bear, Sitka blacktail deer, moose, mountain goat and furbearers. Deer account for 21 percent of the edible pounds of subsistence resources harvested by southeast Alaska communities.

The Kensington Project is not located in prime subsistence territory, past or present.

LAND USE

The project and adjacent area is classified as a LUD II (Land Use Designation) by the Forest Service in the Tongass Land Management Plan as amended during the winter of 1985-1986. Mineral development is allowed on LUD II areas. Historically, the project area has been subject to both mining and milling activitles.

NOISE

Existing background noise levels at the site are affected by the following sources: natural background sounds from wind, rain, and flowing streams; overflights by commuter aircraft travelling between Juneau, Sitka, and Haines; marine traffic along Lynn Canal; and the current exploration operations at the Kensington site.

CHAPTER 4 - ENVIRONMENTAL CONSEQUENCES

This chapter of the DEIS provides the analytical basis for comparison of the project alternatives (Chapter 2). It discusses the anticipated environmental effects associated with implementation of the action alternatives in comparison to the No Action Alternative.

AIR QUALITY

The areal extent of air pollutant concentration increases from the Kensington Project would be very localized and confined to the near vicinity of the site. Annual average nitrous oxides (NO_x) concentrations decrease to levels below detectable limits within about 0.6 mile from the mill site. Similarly, total suspended particulates (TSP) and sulfur dioxide (SO_2) concentrations fall off rapidly with downwind distance, to the extent that both annual average TSP and SO_2 modeled concentrations are less than 1 microgram per cubic meter (ug/m^3) within about 1500 feet of the project boundary (TRC, 1990).

The expected cumulative air quality impact of the Kensington Project in combination with existing and proposed area activities would be negligible.

The emission rates of NO_x, SO_2 and CO are nearly identical for all of the action alternatives (Alternatives B, C, D, and E). The expected TSP emission rates differ considerably. None of the alternatives would result in a violation of National Ambient Air Quality Standards either during construction or operation.

GEOTECHNICAL CONSIDERATIONS

Based on the evaluation of direct and indirect impacts on the project, there are no apparent cumulative geotechnical impacts.

Alternatives A, B, C, D, E, and F include risks which are common to all alternatives including seismic/seiche, landslides and avalanches. With the exception of the No Action Alternative, Alternative B and F have the lowest risk.

Alternative C includes some geotechnical and environmental risks associated with the construction of an access road from the mine site and staging area to the marine terminal facility in Berners Bay. Construction of access roads and placement of fill material for construction in areas currently susceptible to landslides may worsen already unstable conditions and represent a minor geotechnical impact in those areas. Alternative D has geotechnical slope stability risks in the reservoir area of the tailings facility and along the slurry pipeline alignment extending from the mill to the Sweeny Creek tailings area. Tailings site A in Alternative E is immediately down slope, but outside of an avalanche run-out zone.

SURFACE WATER HYDROLOGY

All alternatives would impact flows in Sherman Creek from water withdrawal. An alternative water source would be developed for low flow periods to mitigate flow effects. Cyanide concentrations in the tailings pond would be within drinking water standards. Tailings water would not be released to area streams.

Alternatives B and C have conventional tailings impoundments located in the Sherman Creek drainage. About 5,200 feet of Sherman Creek would be diverted in a pipe around the tailings impoundment. About 2,000 feet of Ophir Creek would be diverted in an open channel. Alternative D has a conventional tailings impoundment that would require diversion of about 6,500 feet of Sweeny Creek. Alternative E would not require major stream channel diversions.

Effects from sedimentation from site development activities would be common to all alternatives. Construction activities would temporarily increase sedimentation in local streams. Drainage and sediment control measures would reduce impacts.

Accidental spills from the marine outfall pipeline (all alternatives), or tailings slurry pipeline (alternative D) could cause short term water quality impacts to Sherman and Sweeny creeks. In the event of a major break, there is a risk that water quality could violate fresh water acute toxicity criteria.

GROUND WATER HYDROLOGY

Water discharge from the underground mine would be collected and pumped to the surface treatment facilities. Water quality would be monitored. At the time of mine closure, the portals would be sealed and workings below the lower portal would flood. This would limit free oxygen reaction with any acid generating minerals left in the mine. Impacts to ground water from development of any of the action alternatives would not be significant.

All the action alternatives would have varying degrees of ground water impacts in the project area. The degree of impact would depend on the number of watersheds affected by each alternative. Ground water quality impacts would be minimized in Alternatives B, E and F which locate the project in one watershed. Impacts to ground water as a result of any of the action alternatives are not expected to be significant.

AQUATIC RESOURCES - MARINE

Marine discharge was evaluated at both 50 m depth and 100 m depth using diffusers designed for each location. At 100 m depth, the mixing zone (defined as the region within the discharge plume where one or more marine aquatic life standards are not met) varies from 261 to 1,143 cubic meters. At 50 meters depth the mixing zone varies from 176 to 267 cubic meters. The variances are due to seasonal differences in Lynn Canal waters combined with variations in effluent flow rates. The mixing zone is confined to an area within 15 m of the seafloor at 100 m depth and within 6 m of the seafloor at 50 m depth. Impacts associated with marine discharges from the project would be essentially the same under all action alternatives.

Background pollutant loading in Lynn Canal would not change measurably from current conditions. Changes in metals pollutant loading in seafloor sediments would likewise not be measurable. No significant impacts would be expected to commercially important species due to the marine discharge.

Mill effluent under Alternative B would not meet draft NPDES discharges limits for suspended sediments. All other alternatives would meet the draft NPDES permit limitations.

Bioaccumulation of metals is not expected to occur in any marine organisms. As a result, transfer of contaminants to higher tropic levels through biomagnification is not expected.

Biological effects associated with construction and operation of a marine terminal at Comet Beach would be identical for Alternatives B, D, E, and F. Impacts would be greater for a terminal at Slate Creek Cove (Alternative C).

The risk of accident while off-loading supplies and fuel at Comet Beach (Alternatives B, D, E, and F) could be greater than at Slate Creek Cove (Alternative C). To reduce the risk, the Kensington Venture has committed to only unloading barges at Comet Beach when waves are less than 3 feet. Impacts of a major fuel spill in Berners Bay, as could occur in Alternative C, could result in substantial loss of marine life within that estuarine habitat.

AQUATIC RESOURCES - FRESHWATER

Impacts of the proposed project would be concentrated in a single drainage in three of the action alternatives (B, E, and F). With the other two alternatives (C and D), impacts would occur in two drainages, though relatively minor impacts would only occur in the second drainage in Alternative C.

Anadromous populations would be subjected to flow reductions in all alternatives. Potential impacts would be highest for Alternatives B, C, and F and least for Alternative E. Alternative D would spread impacts associated with low flows between two drainages. Alaska Department of Natural Resources (ADNR) would develop minimum low flows for affected streams. These flows would be used to regulate stream withdrawals. If necessary to protect fisheries, withdrawals would be temporarily stopped.

The risk of spills is considered highest for Alternative C because of the additional distance involved in land transport of toxic products from Echo Cove to the project site.

Major stream diversions would occur for three alternatives (B, C, D, and F) and would result in loss of habitat for resident populations. Habitat losses for Alternative D would involve 6,500 feet of stream with populations of cutthroat and Dolly Varden. Only Dolly Varden would be affected by loss of 5200 feet of habitat in Alternatives B, C, and F. Physical migration barriers prevent anadromous fish from returning to habitats that would be lost. Thus, no effect on anadromous fish is expected.

SOILS/VEGETATION/WETLANDS

All of the action alternatives would impact the soil resources of the project area. The degree of impact would depend on the acreage and configuration of the proposed disturbance. However, proper design of sediment control measures and reclamation scheduling would minimize impacts to the soil resources.

Project development would result in the clearing of vegetation from all project facility areas. At mine closure, disturbed areas would be stabilized and reclaimed according to a Forest Service approved reclamation plan. Due to the abundant rainfall and favorable plant growth conditions in this region, vegetation is expected to rapidly reestablish on stabilized reclaimed areas.

Field investigations on several previously disturbed wetland areas within the Sherman Creek basin at the old Kensington mill site, as well as along the old roads, railroad and tramways suggest that the potential for wetlands reestablishment on disturbed areas is very high.

No federal or state listed threatened or endangered plant species are known to occur in the project area. Field surveys verified the existence of one proposed state listed species, *Betula papyrifera* var. *commutata*. Approximately six populations of this plant

located in the Sherman Creek basin, could be impacted.

Project disturbances would be: Alternative B; 275 acres, Alternative C; 392 acres, Alternative D; 229 acres and Alternative E; 237 acres Alternative F; 277 acres. Wetlands disturbed by the project would be: 233 acres in Alternative B, 336 acres in Alternative C, 124 acres in Alternative D, 182 to 229 acres in Alternative E, and 235 acres in Alternative F. Losses of old-growth forest by alternative are: 86 acres for Alternative B, 121 acres for Alternative C, 152 acres for Alternative D, 105 to 145 acres for Alternative E, and 86.5 acres for Alternative F.

Anticipated impacts to soils, vegetation and wetlands resulting from the action alternatives are proportional to the disturbance areas. Reclamation would eventually mitigate most impacts to soils, vegetation and wetlands. The most notable exceptions are the loss of old-growth forest habitat.

WILDLIFE

Wildlife impacts of the project would result from human presence and habitat losses. Habitat losses are associated with development sites that would not be reclaimed for the duration of project operations (approximately 12 years). Interim reclamation of temporarily disturbed areas and exposed slopes would be initiated during development. Total reclamation would be completed after mine closure. These efforts would not be able to replace old-growth forest habitats.

Habitat disturbance would result in some direct losses of smaller, less mobile species of wildlife, such as small mammals and amphibians, and displacement of more mobile species to adjacent undisturbed habitats until operations cease and reclamation has been completed. Assuming that existing adjacent habitats are at carrying capacity for most species, locally displaced populations would be eliminated for the life of the mine.

Direct habitat loss is expected to have a relatively minor effect on most wildlife populations in the project area. Mountain goat, black bear, and bald eagle are the species of primary concern that would be affected by project development.

Habitat disturbance associated with Alternative B, E, and F would be confined to one drainage. Alternative E would disturb the least amount of habitat and old-growth timber, but has the greatest potential for adverse affects on the Lions Head mountain goat population. Alternative E Is the only alternative which would not directly disturb a drainage bottom by tailings disposal.

Because of the road from Slate Creek Cove to the project, Alternative C disturbs the most upland and wetland habitats. The potential for disturbance of bald eagle nest habitat, waterbird breeding and wintering areas, and small Stellar sea lion haulout areas is greatest with this alternative.

Alternative D would result in habitat disturbance in two drainages but would disturb the least amount of wetland habitat. Noise impacts are projected to be least intrusive to the mountain goat population with this alternative.

Data shows that mountain goats move from summer range at higher elevations to winter range on the ridge between Sweeny Creek and Lynn Canal. Development of any alternative could modify traditional mountain goat movement patterns.

Project development and operational activities would displace wildlife species such as mountain goat and black bear over a much greater area than that directly disturbed by the proposed operation. If habitats are assumed to be at carrying capacity, then displacement of animals would ultimately result in population reductions.

RECREATION RESOURCES

The proposed alternatives are projected to have similar impacts on non-resident and resident recreational experiences, with a few exceptions. Alternative C would result in direct impacts to recreational users of Berners Bay by introducing additional sights and sounds of human activities. This alternative would displace some users from dispersed camping and other activity sites in the Slate Creek Cove area. To minimize

impacts to recreation, no helicopter flights are proposed for weekends under Alternatives B, D, E and F. Bridget Point State Park would have some increase in noise from helicopter operation in Alternative D.

Project components along shorelines have the potential to directly affect users because of the number of recreationists who access the general area in boats. The shorelines within Berners Bay, where most recreational use occurs, are all classified semi-primitive motorized. No shoreline use is documented along Lynn Canal near the project.

Tourists, especially those on cruise ships and ferries, would be affected indirectly and only slightly, if at all, by any of the alternatives.

CULTURAL RESOURCES

Adverse effects to cultural resources are not expected. The historic resources have been documented. No known prehistoric sites exist. Limited ground truthing and testing may be required to confirm the presence or absence of cultural resources at some specific locations within the proposed project area.

Final selection and acceptance of the preferred alternative will dictate where additional cultural resource confirmation work should take place. Mitigation of any discovered resource can take place under a State, Federal and certified local government accepted mitigation plan, thus resulting in no impact to cultural resources.

VISUAL RESOURCES

The visual impacts of the alternatives can be compared by examining the unique component of each alternative. In Alternatives B, D, and E the unique component is the proposed tailings disposal. Further, the tailings disposal component creates the largest and most permanent visual impact in all alternatives. The largest impact is expected from site B in Alternative E. Alternatives B, C, and F are the same except for the 8.5 mile long access road in Alternative C. Alternative D has the least visual impact of all the alternatives.

SOCIOECONOMICS

Socioeconomic impacts for the Kensington Project are primarily driven by population. All of the action alternatives have similar employment levels. The range among the alternatives is not large enough to firmly establish differences in the impacts generated by each. The range of error for estimates, and the flexibility and adaptability of community socioeconomic systems means that the action alternatives all have the same impacts.

Alternative D has the highest capital cost for any of the alternatives but the low tax levies substantially reduce potential revenues generated by the alternatives, and narrows the difference among them.

Two projections of Juneau population were used to describe a range of Kensington Project induced population impacts. Under both projections, the largest impact would be felt during the first 6 years of project life. During this period, state employment would stay high and the community would have little capacity to absorb population increases. In later years, mine development helps offset expected population declines. This effect lasts until the mine closes. At that time population declines even farther.

With the current tight housing situation, initial project impacts would mean that about 411 new housing units would be needed during the next 4 years. About 260 new students are expected to enter the school system which currently has capacity problems. Work loads on other public services, such as fire and police, are expected to increase with population. CBJ expenses would exceed revenues in the early years of the project by as much as $809,000. Near the end of project life, revenues would exceed expenses. Estimated net fiscal loss to the community is expected to total about $6.8 million over the life of the project.

Cumulative population effects of adding both the Kensington and AJ projects to the Juneau area would cause the population to peak at about 31,712 in 1999. If both mines closed simultaneously, Juneau's population could decline by 3,000 persons. This would be a 9.4 percent decline, about twice as large as the

1985 - 1988 population decline. Estimated net fiscal gains to the community are expected to total about $30.4 million over the life of the two projects.

It is not likely that any of the alternatives would generate significant impacts on Haines or Skagway.

Estimated net fiscal loss to the community is expected to total about $6.8 million over the life of the project.

TRANSPORTATION

The majority of the Kensington Project workforce would live in Juneau. Residents of Haines, Skagway and other surrounding communities employed at the Kensington Project would use the existing transportation system, commercial airlines, and Alaska Marine Highway to get to Juneau to meet the company-provided transport to the mine. These non-Juneau residents would be few in number, consequently their impact on the existing transportation facilities would be insignificant.

During the construction phase, Lynn Canal marine traffic would increase. On average, about three equipment/supply and fuel barges would come into the Comet Beach barge landing area every week. The impacts of increased traffic in Lynn Canal would be insignificant to cruise ships, barges, ore ships, etc.

Conflicts between barge traffic and gillnetting operations could occur. These conflicts can be minimized by a perpendicular barge approach into Comet Beach. Radio contact between barge operators and gillnetting boats would also help to minimize conflicts.

In Alternatives B, E, and F employees would be transported to the mine from the Juneau Airport via helicopter. The additional 3 to 5 round trips per day resulting from the regular transport of Kensington employees to and from the project would not adversely impact the Juneau Airport.

In Alternative C, transportation of employees to the project would be by ferry from Auke Bay to a new marine terminal at Slate Creek Cove in Berners Bay. A bus would take the workers from the Slate Creek Cove marine terminal to the mine. There is no regularly scheduled commercial marine traffic in Berners Bay, consequently the impacts on other commercial marine transportation would be insignificant.

Under Alternative D, employees would be transported by helicopter from a site in the Yankee/Bridget Cove area. Flight schedules would be the same as under Alternative B. Traffic would increase on Egan Drive and Glacier Highway as a result of employees driving to the heliport. Up to 40 vehicles per hour could be expected during shift changes.

SUBSISTENCE

It is unlikely that any adverse effects would occur to subsistence resources or practices. Subsistence practices for the immediate project area are not documented. Secondary effects to migratory marine species are not expected. Sport hunting and fishing may increase competition for resources with subsistence users elsewhere.

LAND USE/RECLAMATION

The LUD II designation of the Kensington Project area accommodates mineral development. Thus, approval of any of the alternatives, including the No Action Alternative, would not significantly affect land use or land use planning on the Tongass National Forest.

A comprehensive reclamation plan would reduce any potential for long term impacts to the environmental resources of the area. The degree of impact would be a function of both the area disturbed and revegetation success. The tailings structure would require specific reclamation and maintenance programs to maintain structural integrity.

NOISE

Noises would include continuous noise from sources such as the mill and power plant and intense intermittent sources such as waste rock dumping and spreading at the tailings disposal site. Mill and power plant noise levels in nearby mountain goat and bear habitat are less than background value. It is unlikely that the mill and power plant would be heard there. The short

term noises caused by the intermittent sources (e.g., tailings dam construction and helicopter flights) would be clearly audible up to 1.75 miles from the source.

The noise impacts caused by Alternative C were modeled to be identical to Alternative B. Noises from the Berners Bay terminal would be heard throughout Berners Bay.

The noise impacts caused by Alternative D (Sweeny Creek Tailings Dam) would be less significant in the mountain goat habitat north of the project site. The loudest noise source, tailings dam construction, would be removed from those habitat areas.

The noise impacts caused by Alternative E were modeled to be the most significant of any of the project alternatives. The semi-continuous dry tailings dumping, spreading, and compaction operations were modeled to be clearly audible in the surrounding wildlife habitat. None of the noises would be audible at Berners Bay.

Except for traffic at the Berners Bay marine terminal in Alternative C, noise caused by additional marine traffic and aircraft overflights would probably have no significant effect on wildlife or recreationists because the incremental increase in traffic resulting from the Kensington project would be small compared to the existing traffic volumes.

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INTRODUCTION

This Environmental Impact Statement (EIS) was prepared in order to consider an application for a Plan of Operations from the Kensington Venture to develop, construct, and operate a gold mine in accordance with the Kensington Venture's project description. The Kensington Venture is a joint venture between Coeur Alaska, Inc. (a subsidiary of Coeur d'Alene Mines Corporation) and Echo Bay Exploration, Inc. (a subsidiary of Echo Bay Mines Ltd.). The Kensington Venture will prepare and submit a Plan of Operations to the Forest Service following completion of a Final Environmental Impact Statement (FEIS).

This EIS was prepared by ACZ Inc. under the direction of the U.S. Department of Agriculture, Forest Service, Tongass National Forest (Forest Service) which is the lead agency responsible for preparation of the EIS. The U.S. Army Corps of Engineers and Environmental Protection Agency (EPA) are cooperating agencies to the Forest Service in preparation of this EIS (40 CFR 1501.6). Comments on the Draft Environmental Impact Statement (DEIS) were used by the Forest Service, the U.S. Army Corps of Engineers, and the EPA (Region 10) to complete the FEIS. The same comments will aid in the decision-making processes related to the issuance, or denial, of the permits required for the Kensington Gold Project.

All aspects of the Kensington Venture's proposed operations, as they affect National Forest surface resources, will be subject to a Plan of Operations (36 CFR 228) approved by the Forest Service. The Forest Service determined that approval would be a major federal action and that the proposed operation may significantly affect the human environment. Because of this determination, an EIS must be prepared to fulfill the requirements of the National Environmental Policy Act (NEPA) of 1969, the Forest Service regulations at (36 CFR 228), and the Council of Environmental Quality (CEQ) regulations (40 CFR 1500). The EIS must analyze the direct, indirect, and cumulative impacts associated with the proposed operation. Based on this analysis, the Forest Service response may be to approve or deny the Plan of Operations as proposed, or to require modification of the Plan.

PURPOSE OF AND NEED FOR ACTION

The Kensington Venture proposes an underground gold mine, mill, and associated facilities known as the Kensington Gold Project. The project site is located on the west side of the Kakuhan Range adjacent to Lynn Canal, approximately 45 air miles north of Juneau and 35 air miles south of Haines, Alaska. (*See Figure 1-1, General Location Map*).

Figure 1-1, General Location Map

The mine would produce about 4,000 tons of ore and 400 tons of underground development waste rock per day for approximately 12 years. Expected gold production is about 200,000 ounces per year. The work force would be about 340 people during full production. Additional details on the Kensington Gold Project proposal can be found in Chapter 2 and in the DEIS (Appendix A, Applicant Proposal).

The purpose of and need for the proposed action is to develop and operate an underground gold mine within the Kensington Venture's claims boundary. The proposed project is consistent with the Mining Law of 1872 and its principal amendment of July 23, 1955.

Under the Mining Law of 1872 et seq. qualified prospectors may search for mineral deposits on public domain lands open to mineral entry.

Upon discovering a valuable mineral deposit, a prospector may locate a mining claim. A mining claimant is entitled to reasonable access to the claim for further prospecting, mining, or necessary related activities, subject to other laws and applicable regulations. Because the proposed operations would be located primarily on public lands in the Tongass National Forest, compliance with the guidelines described in the Tongass Land Management Plan (USFS, amended, 1986) in addition to development under U.S. Mining Laws is required. The project site occurs within an area designated as Land Use Designation (LUD) II in the Tongass Land Management Plan (TLMP). The TLMP states the following purpose for LUD II:

> "Areas allocated to LUD II are to be managed in a roadless state to retain their wildland character, but this would permit wildlife and fish habitat improvement and primitive recreation facility development."

Management implications for LUD II areas state that "Mineral development is subject to existing laws and regulations (USFS, amended, 1986).

U.S. Mining Laws and TLMP recognize the statutory right of mining claim holders to explore and/or develop mineral resources and encourage such activity consistent with the Mining and Mineral Policy Act and the Federal Land Policy and Management Act. These regulations require responsible federal agencies to review applicant's Plan of Operation to ensure that: 1) adequate provisions are included to minimize, where feasible, adverse environmental impacts on public land surface resources; 2) measures are included to provide for reclamation, where practicable; and 3) the proposed operation will comply with other applicable federal and State laws and regulations.

RESPONSIBLE OFFICIAL AND DECISION TO BE MADE

The Forest Service is following a specific procedure that began with scoping and data collection and continues with analysis of data to evaluate alternatives. The results of these analyses are documented in this EIS and form the basis for the Forest Supervisor's decision on the project. The Forest Supervisor for the Chatham Area of the Tongass National Forest is the Responsible Official for this decision.

The responsible official may decide to:

- Adopt the No Action Alternative
- Adopt one of the action alternatives
- Adopt an alternative that combines features of more than one alternative
- Adopt one of the action alternatives with additional mitigation measures

The Record Of Decision (ROD) will result in an action on the Kensington Plan of Operations (permit application). The Forest Service will either approve, deny, or require that Kensington revise the Plan of Operations prior to approval.

SCOPING AND PUBLIC INVOLVEMENT

As required by NEPA (CEQ 1501.7), the Forest Service has provided for an early and open process to determine the scope of issues to be addressed and to identify the significant issues related to the Kensington Gold Project.

The Forest Service accomplished this goal by holding agency and public scoping meetings, by forming an Interdisciplinary (ID) Team, preparing a Draft Scoping Document (dated April 23, 1990) and a Final Scoping Document (dated July 31, 1990). A DEIS was released June 1, 1991 for public comment.

AGENCY SCOPING

On October 19, 1989, the Forest Service held an agency scoping meeting to discuss the Kensington Gold Project. Representatives from the Forest Service, EPA, U.S. Fish and Wildlife Service (USFWS), City and Borough of Juneau (CBJ), National Marine Fisheries Services (NMFS), Alaska Department of Natural Resources (ADNR), Alaska Department of Fish & Game (ADF&G), Alaska Department of Environmental Quality (ADEC), Alaska Division of Governmental Coordination (ADGC), and

Alaska Department of Transportation (ADOT) were present.

PUBLIC SCOPING

Public scoping meetings were held to receive input from concerned citizens. On December 13, 1989 a public meeting was held in Juneau. Public meetings in Haines were held on January 9, 1990 and May 10, 1990. The Forest Service has accepted public comments throughout preparation of this document.

ID TEAM

The ID Team was formed by the Forest Service under its guidelines for compliance with NEPA regulations. One of the primary purposes of the ID Team is to establish the scope of the EIS. Members of the ID Team are listed in Chapter 5.

DRAFT EIS

The Forest Service continued to take public comment following publication of the DEIS on June 1, 1991. A public comment period of 61 days was scheduled to close on August 1, 1991. During this time two public hearings were held.

Approximately 150 people attended the first hearing on July 12, 1991, at Centennial Hall, Juneau. The agenda for this hearing included an open question and answer period before the testimony. The Forest Service's and ACZ's interdisciplinary team were available to answer questions about the project and its expected effects on the environment. About 13 people asked questions of the panel. Twenty-eight people gave testimony.

About 80 people attended the second hearing on July 19,1991, at Chilkat Center, Haines. The agenda was identical to that used in the first hearing. About 10 people questioned the panel and 31 people gave testimony.

Many people expressed concern that the two-month comment period did not allow time to review and comment on the information presented in the DEIS. Concern was also expressed about the scheduling of public meetings. In response, the Forest Service extended the comment period to September 3, 1991, giving a total of 94 days for public input.

Two water quality workshops were scheduled during this extended comment period. The workshops were day-long open forums held August 8 at the Chilkat Center in Haines and August 9 at Juneau's Centennial Hall. The workshops were held in conjunction with EPA's NPDES Permit hearings.

Transcripts of the oral testimony are on file at the Juneau Ranger District. All written comments are available as Appendix A to this FEIS.

ISSUES AND CONCERNS

Scoping for the Kensington Gold Project was conducted to focus the EIS on those issues considered important to the public and various government agencies. A Draft Scoping Document was prepared and published with the following stated purposes.

- Describe the project
- Identify government involvement
- Describe the role of the public in the EIS preparation process
- Discuss the permitting process and its relationship to EIS preparation work
- Document relevant issues and preliminary options that we have identified for the project
- Describe the proposed process for the development of alternatives which will eventually be discussed in the DEIS
- Inform the public and governmental officials regarding the project

Following publication of the Draft Scoping Document, the Forest Service continued to consider written statements and comments to help in the preparation of a Final Scoping Document. Issues and concerns were raised by the public, cooperating agencies, other agencies, Forest Service technical specialists, and technical representatives of the third-party contractor.

From this input, significant issues specific to the proposed Kensington Gold Project were summarized and used as part of the criteria for completing this DEIS. Issues also were

analyzed by the ID Team for screening options, selecting alternatives, and evaluating consequences. Following is a brief synopsis of the issues.

SOCIOECONOMICS

Address the social and economic impacts on the local residents in Juneau, Haines and Skagway. Socioeconomic impacts to the communities of Juneau, Haines, and Skagway such as housing, utilities and services, and employment must be specified. The influx of workers and their families and its effect on housing demand, public and community services, and present lifestyles of local residents must be addressed. The corresponding effects of temporary and permanent mine shutdown must also be addressed.

FISHERIES

Maintain quality of existing fish habitats and minimize impacts to resident and anadromous fish which support an important commercial fisheries industry in Lynn Canal. Fish habitats could be affected by direct disturbance of stream channels, reduced flow, and/or water quality degradation. Protection of spawning and rearing habitat must be considered. The proposed marine outfall and mixing zone must be assessed for impacts to aquatic organisms. Protection of the existing commercial fishery is a priority for many members of the public. The potential for chemical spills or catastrophic dam failure must be addressed.

MARINE TRANSPORTATION

Minimize disruption to marine traffic in Lynn Canal, especially commercial fishing. The potential to conflict with commercial fishing activities within Lynn Canal, especially around the Point Sherman area, should be addressed. Transportation of employees and supplies to the site should consider other users within Lynn Canal. Spills of hazardous materials could impact uses of Lynn Canal.

WATER QUALITY

Maintain the integrity of affected watersheds by minimizing impacts to water quality and maintaining proper flows. The potential to alter the characteristics of hydrologic systems by direct disturbance of stream courses, increased downstream sediment loads, alteration of downstream flow rates, and degradation of water quality as a result of milling reagent chemicals or sanitary facility pollution must be addressed. Water quality must be monitored for compliance with existing laws.

Maintain water quality in Lynn Canal. The potential to affect both water quality and metals loading in Lynn Canal sediments as a result of the marine outfall must be evaluated.

RECREATION

Minimize disruption to recreation opportunities. The facilities developed for the proposed project should be designed, constructed, and maintained to minimize disruption to recreational opportunities in Berners Bay by minimizing visual impacts, noise, and marine traffic. The impacts to cruise ships and ferries in Lynn Canal should be identified.

VISIBILITY/AIR QUALITY

Minimize visual impacts of the operation from Lynn Canal and Berners Bay. The expressed concerns for the project include effects on air quality from fugitive dust and gaseous emissions. Also, the visual impacts of the tailings impoundment and other surface facilities for individuals using Lynn Canal and/or Berners Bay must be considered.

LAND USE/RECLAMATION

Minimize disturbance by maintaining a compact operation. The area is designated as LUD II by the Tongass Land Management Plan. The area is to be managed to protect its wildland character while also protecting the claimant's rights under U.S. Mining Laws. Reclamation must be assured to prevent or control damage to the environment. Reclamation must be guaranteed by adequate financial assurances (bonding) from the Applicant.

WILDLIFE

Minimize disruption to wildlife and wildlife habitats. The proposed project has a potential to alter the nature of wildlife use and the productivity of wildlife habitats. Of particular concern are possible impacts to mountain goat, brown bear, and black bear. Alternatives should minimize noise, human activity, and habitat destruction as they relate to the wildlife species in the area.

SUBSISTENCE

Identify subsistence resources and level of use within the project area. The potential to affect subsistence opportunities by either direct impact to the Berners Bay and Lynn Canal areas and/or indirect impacts resulting from increased population must be analyzed. Also, measures to mitigate adverse impacts, if present, should be developed and presented.

CUMULATIVE IMPACTS

Address the cumulative impacts of this and other potential development projects. The facilities developed for the proposed project must consider the influence of possible mining development in the region, especially environmental effects in Lynn Canal/Berners Bay area and the socioeconomic effects to the economies of Juneau, Haines, and Skagway.

TECHNICAL FEASIBILITY

Minimize chances of system failure by incorporating technically feasible component siting, design, and mitigating features. The technical feasibility of various project components must be addressed. If components of the project become too complex or utilize uncertain technology, then an increased risk of failure could result. Specific concern has focused on items such as tailings dam failure or uncontrolled chemical discharges.

ECONOMIC FEASIBILITY

Component design should be cost effective. If project costs exceed reasonable or practical limits, economic feasibility could become an issue. Alternatives must be economically reasonable and financially feasible.

OTHER ACTIVITIES NEAR THE PROJECT

A number of activities occur in the region surrounding the Kensington Gold Project. They are mineral resource work, tourism activities, commercial fishing, and recreation.

MINERAL EXPLORATION, DEVELOPMENT AND OPERATIONS

Mineral resource activities are now underway in southeast Alaska, western British Columbia, and southern Yukon Territory; most of these activities are focused on exploration.

The Greens Creek Mine is an example of an operating mine. No major mines are in the development (or construction) phase in the Juneau area. Numerous mineral exploration programs are underway in the region; these programs all vary in size and extent. (*See Figure 1-2, Mineral Exploration and Mining Activities*). Mining and exploration projects within the general vicinity of and including the Kensington Gold Project are addressed in the following discussion.

Additional information regarding mineral exploration, development, and operations within southeast Alaska, western British Columbia, and the southern Yukon Territory is given in the DEIS (*Appendix B, Regional Mineral Activity*).

Kensington Gold Project

At present, the Kensington Venture partners are conducting exploration activities on claims in the Sherman Creek watershed. These activities have included the development of a mile-long adit to reach the Kensington vein system. Underground diamond drilling is being utilized to delineate the vein system and evaluate the ore grades. Exploration activities have occurred under an operating plan and subsequent amendments approved by the Forest Service. Forest Service approval included preparation of four separate environmental assessments

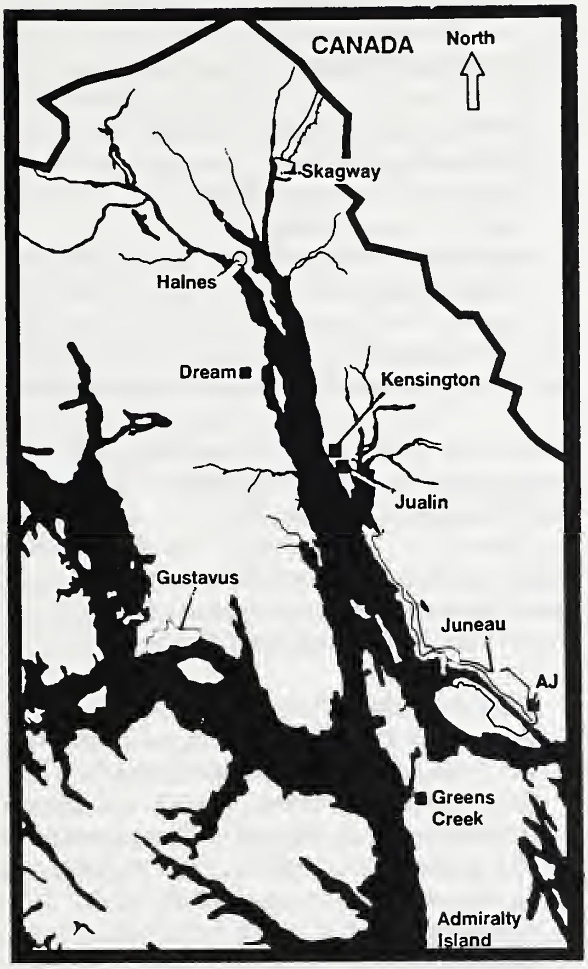


Figure 1-2, Mineral Exploration and Mining Activities

(EAs) under NEPA. EAs were approved on January 4, 1988, February 23, 1988, and November, 1990 and July 17, 1991. A proposal for mining has been filed with the Forest Service. The Forest Service is considering the proposal.

Jualin Project

Placer Dome U.S., Inc. (Placer Dome) and several junior partners are currently engaged in precious metal exploration activities on a site adjacent to Berners Bay. Placer Dome is presently working under an operating plan approved by the Forest Service. An environmental assessment dated March 23, 1988 and June 19, 1991, had been prepared for the site and are on file with the Forest Service. Placer Dome is presently conducting seasonal surface drilling. Representatives of Placer Dome have informed the Forest Service that no current mining or milling plans exist for their Jualin property. They indicated that considerable additional exploration activities will need to be conducted prior to reaching any decision regarding development of a mining and ore processing facility onsite. However, Chapter 2 of the EIS discusses potential long-term joint facilities options and alternatives between this project and the Kensington Gold Project.

Alaska Juneau (AJ) Project

Echo Bay Exploration Inc. is conducting exploration work at the old Alaska Juneau Mine located near downtown Juneau. The firm has filed a Right-of-Way application with the Bureau of Land Management, and a DEIS has been prepared for the AJ Mine. Existing projections are for a 22,500 tons of ore per day operation with a full time work force of 450 people. The AJ Mine is projected to recover about 364,000 ounces of refined gold annually over a projected mine life of 13 years. Two years of construction would be required prior to initiation of mining. Mining would be by underground techniques.

Greens Creek Mine

The Greens Creek Mine, operated by Kennecott, is located about 15 miles west of Juneau near Hawk Inlet. The Greens Creek Mine went into operation in February of 1989, and the first bulk shipment of ore concentrates left Hawk Inlet in May of 1989. The operation produces concentrates of silver, zinc, lead, and gold. Approximately 1,000 to 1,100 tons of ore per day are currently mined by underground methods. The Greens Creek operation employs 210 full time workers earning an annual payroll of nearly $10,000,000. Workers live in Juneau and commute to the mine daily via ferry. The operation has a projected life of 10 years. The Forest Service understands that known ore reserves at this project have recently increased significantly. This will probably result in some extension of project life, expansion of the project or combination of these two responses.

Dream Project

International Curator and Placer Dome, Inc. conducted exploration activities on this sulfide prospect, located approximately 50 air miles north of Juneau on the west side of Lynn Canal. Due to the disappointing results of the 1990 drilling program, the operators have dropped their lease on the Dream claims.

TOURISM AND RECREATION

Large cruise ship lines use Lynn Canal in the summer season for trips to Skagway and Haines as part of their "See Alaska" tourism package. In addition, the Alaska Marine Highways makes scheduled trips past the Kensington site to the towns of Haines and Skagway.

Berners Bay is used for recreation by Juneau citizens and others. Kayaking, sport fishing, and air boating are popular recreational pastimes.

COMMERCIAL FISHING

Commercial fishing occurs throughout Lynn Canal, including Berners Bay. Commercial fishing activities are conducted primarily from May through October. Both gillnetting and long-line fishing techniques are used. Commercial fish species harvested include halibut and salmon.

AGENCY RESPONSIBILITIES (PERMITS AND APPROVALS)

A number of federal, State, and local permits and approvals will be required for the Kensington Gold Project.

Preparation of an EIS and the permitting processes are related but distinct. An EIS is designed to explore project alternatives and discuss relative environmental impacts. The permitting process gives individual government decision makers the authority to grant individual permit applications with requirements and conditions to eliminate and/or mitigate specific adverse environmental impacts which are identified in the EIS.

FEDERAL GOVERNMENT

Environmental Protection Agency

1. NEPA compliance and ROD on FEIS (Cooperating Agency)
2. Clean Water act compliance
3. Clean Air act compliance
4. Notification of Hazardous Waste Activity (Cooperating Agency)

EPA is a cooperating agency with the Forest Service on the Kensington Gold Project EIS.

Wastewater discharge from the Kensington mining and milling operations would be authorized, or denied, by EPA.

The Clean Water Act has established the following surface water programs which will apply to the Kensington Gold Project.

- Natural Pollutant Discharge Elimination System (NPDES) Permit program regulating the point source discharge of pollutants.
- The Section 404 Permit program regulating the discharge of dredged or fill material.
- The Section 311 program Spill Prevention Control and Countermeasures (SPCC) regulating spills of oil and hazardous substances.
- The Section 319 program regulating non-point pollution.

NPDES Permit Program. Sections 301 and 306 of the Clean Water Act require that EPA develop wastewater effluent standards for specific industries, including gold mines. These standards are established both for existing sources and new sources. The Kensington Gold Project will require an EPA NPDES Permit. The NPDES program was established by Section 402 of the Clean Water Act. Because the project is also a new source, New Source Performance Standards for gold mines and mills are applicable to the project (40 CFR 440.104).

In accordance with Section 511(c)(1) of the Clean Water Act, NPDES Permit actions for new sources are subject to NEPA (40 CFR Part 6,

Subpart F). EPA will issue a ROD in conjunction with the final permit action.

EPA is the NPDES permitting authority in Alaska. The ADEC, pursuant to Section 401 of the Clean Water Act, must provide certification to EPA that the discharge will comply with any applicable State water quality standards. The ADEC certification is where wastewater mixing zones are (are not) permitted.

Section 404. Section 404 of the Clean Water Act authorizes the U.S. Army Corps of Engineers to issue permits for the discharge of dredged or fill materials into waters of the United States. EPA, under Section 404 (c), may prohibit or withdraw the specification (permitting) of a site upon a determination that the use of the site would have an unacceptable adverse effect on municipal water supplies, shellfish beds and fishery areas, or recreational areas. These permits are addressed under the heading, "U.S. Army Corps of Engineers," which immediately follows this discussion.

SPCC Plans. Section 311 of the Clean Water Act establishes requirements relating to discharges or spills of oil or hazardous substances. Discharges or spills of oil in "harmful quantities" are prohibited. EPA has established a requirement for the preparation of a SPCC Plan by facilities that handle substantial quantities of oil. The Applicant has prepared an initial SPCC Plan which is included in Appendix A. This Plan will be modified, as necessary, once the preferred alternative is identified and included in the final Plan of Operations submitted to the Forest Service.

Non-Point Source Control Program. EPA has recently promulgated regulations for control of stormwater runoff. At the Kensington project these sources would include runoff from roads, laydown areas, helipad, and other surface disturbances that are not directed to the tailings pond. The Kensington Venture will be required to apply for a stormwater permit under this program. The EPA approach to non-point source discharge is generally to require implementation of best management practices (BMPs).

The Forest Service under its authority as surface manager, will require the implementation of BMPs (USDA Forest Service, 1991). The Forest Service BMP program and EPA requirements are very similar.

Clean Air Act. In addition to water quality oversight, EPA also maintains control over the air resources of an area as outlined in the Clean Air Act. The Clean Air Act's most basic goals are to protect public health and welfare. EPA will conduct, in accordance with Section 309 of the Clean Air Act and NEPA, overall reviews of the EIS.

EPA approves the Alaska (Air Quality) State Implementation Plan (SIP) and reviews Air Quality Control Permit to Operate applications, including Prevention of Significant Deterioration (PSD) requirements. The Air Quality Control Permit to Operate is issued by the ADEC. Prior to commencement of construction of any major stationary source or major modification of such sources, ADEC will conduct a review of a planned operation. The PSD process requires a pre-construction review and, if a permit is required, an impact and technology analysis. An opportunity for public hearing prior to permit issuance is required and will be administered by the ADEC.

The PSD regulations generally define a "major stationary source" as, in the case of mining, any operation that emits or has the potential to emit 250 tons a year or more of any pollutant regulated under the Clean Air Act. Pollutants can include both fugitive (dust) and gaseous (sulfur dioxide, carbon monoxide, nitrous oxides, and hydrocarbons) emissions.

U.S. Army Corps of Engineers

1. NEPA compliance and ROD on FEIS (Cooperating Agency)
2. Section 404 Permit - Clean Water Act (Dredge and Fill)
3. Section 10 Permit - Rivers and Harbor Act

The Corps of Engineers is a cooperating agency with the Forest Service on the Kensington Gold Project EIS.

Section 404 Permit. Section 404 of the Clean Water Act authorizes the U.S. Army Corps of Engineers to issue permits for discharge of dredged or fill material into waters of the United

States. The Act prohibits such a discharge except pursuant to a Section 404 Permit. To the degree that they impact "waters of the United States," various activities undertaken in connection with mining operations may require a Section 404 Permit (including road or bridge construction, construction of dams for tailings storage, water storage dams, stream diversion structures, etc.).
The Corps of Engineers is responsible for determining the consistency of the proposed 404 action with the Section 404 (b)(1) guidelines. A Section 404 Permit cannot be issued without Section 404 (b)(1) compliance.

The Corps of Engineers must comply with Executive Orders 11990 and 11988 with respect to impacts to the nation's wetlands and/or floodplains. There is currently an emphasis on a "no net loss" wetlands policy as outlined in an agreement between the Corps of Engineers and EPA. This policy is presently under review to determine the most appropriate implementation practices for Alaska. Wetlands in the area to be affected by the Kensington proposal were identified using the Federal Manual for Identifying and Delineating Jurisdictional Wetlands (Federal Interagency Committee for Wetland Delineation., 1989).

Section 10 Permit. Pursuant to the Rivers and Harbors Act of 1899 and Section 103 of the Marine Protection, Research and Sanctuaries Act, the Corps of Engineers has permitting authority to regulate various activities impacting traditionally navigable waters. Pursuant to Section 10 of the Rivers and Harbors Act of 1899, a permit is required for any structure or work that may obstruct traditionally navigable waters. A Section 10 Permit will be required for the Kensington Project marine terminal.

U.S. Fish and Wildlife Service

1. Threatened and Endangered Species Consultation
2. Bald Eagle Protection Act Clearance

The USFWS administers the Endangered Species Act, as re-authorized in 1982, and the Bald Eagle Protection Act of 1940, as amended. On the Kensington Gold Project, the Forest Service must consult with the USFWS regarding any threatened or endangered species that might be impacted by the proposed operation. If any impacts are projected, specific design measures to protect the affected species must be developed.

National Marine Fisheries Service

1. Threatened and Endangered Species Clearance

On the Kensington Gold Project, the Forest Service must consult with the NMFS in accordance with the Endangered Species Act and the Marine Protection, Research and Sanctuaries Act. If any impacts are projected to any threatened or endangered marine species, specific design measures to protect the affected species must be developed.

U.S. Coast Guard

1. Notice of Fueling Operations
2. Permit to Handle Hazardous Materials
3. Application for Private Aids to Navigation

Because the Kensington Venture plans to barge fuel and other materials to the site, the Kensington Venture must notify the Coast Guard of planned fueling operations and obtain a permit to handle hazardous materials shipped to the site. If the Kensington Venture plans to place private aids to navigation in and around its marine terminal, the Coast Guard must be notified and the navigational aids approved prior to their installation and operation. Marine transportation to and from the site will be subject to Coast Guard Navigation Rules.

Federal Aviation Administration (FAA)

1. Notice of Landing Area and Certification of Operation
2. Determination of No Hazard

The FAA must be notified of any airfield construction plans and a certificate of operation must be obtained from this agency. In addition, the FAA may need to make a determination of "no hazard" regarding an airfield for final approval to be obtained to develop the facility. Likewise, any private aids to aircraft navigation installed at an airfield would need to be certified and approved by the FAA.

Federal Communications Commission (FCC)

1. Radio and Microwave Station Authorizations

The Kensington Venture will need to obtain radio and microwave station authorizations from the FCC. These licenses must be obtained for any two-way radio installations made at the project site.

U.S. Treasury Department (Bureau of Alcohol, Tobacco and Firearms)

1. Explosives User Permit

Interstate transportation of explosives is regulated by the Bureau of Alcohol, Tobacco and Firearms. The Kensington Venture or its explosive supplier will need to obtain a license for transport of such explosives to the site. In addition, an explosives user permit will also be required by this agency.

U.S. Mine Safety & Health Administration (MSHA)

1. Mine I.D. Number
2. Legal Identity Report
3. Miner Training Plan Approval

Worker health and safety aspects of the Kensington Gold Project would be regulated by Federal Health and Safety Standards. Authorized MSHA representatives will make routine inspections of the operation and also will be involved in educational and safety training programs. The Kensington Gold Project will be responsible to provide MSHA with reports of accidents, injuries, occupational diseases, and related data. Specific programs for the education and training of all employees are also part of the Health and Safety Regulations of MSHA.

U.S. Bureau of Mines

The Bureau of Mines has no permitting responsibilities associated with mining. However, this organization is an important government agency with its function primarily targeted at research. The Bureau of Mines routinely consults with other federal agencies regarding mining and conducts research which is necessary to achieve technological advancement in the mining industry.

STATE OF ALASKA

Alaska Division of Governmental Coordination

1. Coastal Project Questionnaire
2. Coastal Management Program Certification

The Alaska Coastal Management Program (ACMP) was established by the Alaska Legislature in 1977. The Alaska Coastal Management Act (AS 46.40) provides the legislative authority for the program. The purpose of the program is to provide a streamlined coordinated system for reviewing applications and issuing permits for proposed projects that would effect natural resources in Alaska's coastal zone. This includes proposed mining operations.

Applicants are required to complete the "Coastal Project Questionnaire" to determine which permits are needed for the operation. Copies of the Questionnaire are available from the ADGC. The Questionnaire includes a "Certification of Consistency" which also must be completed and signed by the applicant. It also identifies the responsible Governmental Coordination regional office.

Two sets of State regulations have been adopted for the program. The Alaska Administrative Code (6 AAC 50) contains regulations governing how the State reviews projects for consistency with the ACMP. These regulations were adopted in 1984. Also, the Coastal Policy Council promulgated regulations governing ACMP based on AS 46.40 as 6 AAC 80 and 6 AAC 85. These regulations were adopted in 1979 and subsequently have been amended several times.

Alaska Department of Environmental Conservation

There are a number of permits required by this department for mining operations. They are as follows.

1. Air Quality Permit
2. Burning Permit

3. Certification of Reasonable Assurance
4. Solid Waste Management Permit
5. Oil Facilities Approval of Financial Responsibility
6. Oil Facilities Discharge Contingency Plan
7. Water and Sewer Plant Approval
8. Wastewater Disposal Permit
9. Food Service Permit

Air Quality Permit. The construction, modification and operation of mining facilities that produce air contaminant emissions require an Air Quality Control Permit to Operate. The determination to require a permit is based on the source location, total emissions, and changes in emissions for sources specified in 18 AAC 50.300(a). Generally, the air quality must be maintained at the lowest practical concentrations of contaminants specified in the Ambient Air Quality Standards of 18 AAC 50.020(a) (suspended particulates, sulfur oxides, carbon monoxide, ozone, nitrogen dioxide, reduced sulfur compounds, and lead).

The Applicant must submit the form Air Quality Control Permit to Operate Application and supplemental information as required by 18 AAC 50.300(b). Permits are issued for a maximum 5 year period renewable by the same procedure as the original application. The permit application is subject to "PSD review" by the ADEC and must meet emission limitations established by the EPA New Source Performance Standards.

Burning Permit. An open burning permit is generally required for burning materials which emit black smoke or for controlled burning of vegetative cover. The Applicant must submit a letter for all open burning to the Regional Office of the ADEC or local Air Pollution Control Agency 5 days prior to burning. The open burning of any materials, including timber slash, vegetative cover or solid waste, in certain designated areas is governed by a burning permit. Such a permit may be required at any time during the life of the project. A burning permit is required in designated areas during the fire season, May 1 through September 30. The permit duration will be specified upon issuance, but in no case will it exceed one season. Forest Service authorization is also required when burning on National Forest lands. The Applicant must also notify the federal Aviation Administration regarding burning periods so that wildfire reports are not confused with a managed burn.

Certification of Reasonable Assurance. Activities involving discharge of wastewater or fill material into waters of the United States are not only governed by the terms and conditions of an NPDES Permit from EPA and 404 Permits from the Corps of Engineers but also require Certificates of Reasonable Assurance from the State of Alaska. These certificates can only be issued if they can state that the proposed activity will comply with Section 401 of the Clean Water Act. Alaska marine water quality standards would be used in this process to determine whether or not a mixing zone would be permitted.

Solid Waste Management Permit. A solid waste disposal permit is required to establish, modify, or operate a solid waste disposal facility (except incinerator facilities having a total rated capacity of less than 200 pounds of solid waste per hour). Landfills, incinerators, and composting plants used for the disposal of solid and semi-solid waste including garbage and paper are governed by solid waste disposal permits. State definitions of solid waste may also include waste rock and tailings. ADEC will make these determinations.

The Applicant must submit detailed plans and specifications and certification of compliance with local ordinances and zoning requirements to the appropriate ADEC Regional Office at least 60 days prior to commencement of operations. Public notice is required for this permit, and permits are issued for periods up to 5 years.

Oil Facilities Approval of Financial Responsibility. The Applicant will be required to provide the ADEC with a proof of financial responsibility to compensate for losses due to an oil spill (i.e., containment and cleanup, damages, civil penalties, and civil action). Demonstration of financial responsibility is required 60 days prior to initiating operations and is renewable annually at least 30 days prior to the expiration date of June 30.

Oil Facilities Discharge Contingency Plan. Approval of an oil discharge contingency plan is

required prior to commencement of operations of vessels and oil barges on State waters, or for oil terminal facilities capable of storing 10,000 barrels or more. These contingency plans are reviewed every 3 years.

Water and Sewer Plant Approval. The construction of facilities which collect, treat, and dispose of wastewater is governed by a "plan review" to insure that minimum standards are applied. Plan review requirements involve environmental protection and health and safety considerations of camp operation during mine development and production activities. Plans for the disposal of grey water, sewage, process water, etc. must be reviewed prior to construction of facilities including subsurface wastewater disposal. Sewage and grey water disposal methods must be approved even if a package aerobic sewage treatment plant is installed. Detailed engineering reports, plans, and specifications must be certified by a registered professional engineer. Plans for disposal of wastewater from milling operations would be required as part of an application for a wastewater disposal permit or an NPDES Permit and Certificate of Reasonable Assurance.

Wastewater Disposal Permit. A wastewater disposal permit is currently in place for the on site camp. The permit allows operation of sewage treatment facilities with ocean disposal. This permit and associated treatment facilities will be kept in place for disposal of wastewater generated at or near Comet Beach.

Food Service Permit. Construction and operation of permanent, temporary, and mobile food services, regardless of whether there is a charge for food, is governed by the Alaska Eating and Drinking Establishment Regulations which includes provisions for plan review and issuance of a food service permit. Plan review and permitting procedures will be required throughout the duration of a project. The Applicant must submit Form 06-6030, Application for Permit for Food Service Operation, a minimum of 15 days prior to operation of existing facilities or earlier for construction or extensive remodeling of facilities. A permanent permit does not need to be renewed unless it has been revoked.

Alaska Department of Natural Resources

1. Water Rights Permits
2. Tidelands Lease
3. Permit to Construct or Modify a Dam
4. Right of Way

Water Rights Permits. A water right is an authorization for a property right for the use of public surface and subsurface waters. The right becomes attached to the land when the water is used. Appropriation of a significant amount of water on other than a temporary basis requires authorization by a water rights permit. The application for water rights is made by filing with ADNR the appropriate form and all necessary supporting information.

The terms and conditions of water use are determined in conjunction with a public interest determination process. The terms of a water rights permit are variable and dependent upon the time estimated to be required to complete construction. The various uses of water that would require permits include (but are not limited to) potable water, mining, milling and disposal uses, and diversions for control of downstream and marine water quality degradation.

Permit approval authorizes appropriation but does not secure rights. Once use of the appropriated water has commenced, the ADNR (Division of Water) would issue a Certificate of Appropriation, securing the holder's rights to the water. The Certificate of Appropriation is not automatic; it is dependent upon the actual use of the full amount of water and compliance with all permit conditions. The holder must record the certificate in the District Recording Office for the area of appropriation to guarantee priority against adverse claimants.

Tidelands Lease. A tidelands lease may be required for activities involving a permanent improvement on or of State tidelands and submerged lands. All procedures of the leasing of State tidelands and submerged lands are pursuant to 11 AAC 58.

Permit to Construct or Modify a Dam. A permit is required for the construction, enlargement, alteration or repair (other than routine maintenance) of any dam. The

Applicant must comply with the regulations, 11 AAC 93, Article 3. An application for construction must be submitted to the ADNR, Division of Land and Water Management, Dam Safety and Construction Group. Dam construction is subject to supervision by a registered professional engineer. The supervising engineer must establish an inspection schedule and submit reports within 15 days of each inspection. A Certificate of Approval for the proposed work would be issued by the Division of Land and Water Management upon approval of the design and construction activities. (Review of the dam design will also be part of Forest Service review of the Plan of Operations).

Right of Way. The marine outfall will require a Right of Way to be issued by ADNR.

Alaska Department of Fish & Game

1. Fish Passage
2. Fish Habitat Permit (Anadromous Fish Act)

Fish Passage. The Alaska Statute 16.05.840 (Fishway Act) requires that an individual or governmental agency notify and obtain authorization from the ADF&G for activities within or across a stream used by fish if the department determines that such uses or activities could represent an impediment to the efficient passage of fish. Culvert installation, stream realignment or diversion, dams, low-water crossing, and construction, placement, deposition, or removal of any material or structure below ordinary high water all require approval from the ADF&G. Construction activities must also be coordinated with critical fish spawning periods, where anadromous fisheries are involved.

Fish Habitat Permit (Anadromous Fish Act). Alaska Statute 16.05.870 (Anadromous Fish Act) requires that an individual or governmental agency provide prior notification and obtain approval from the ADF&G "to construct a hydraulic project or use, divert, obstruct, pollute, or change the natural flow or bed" of a specified anadromous waterbody or "to use wheeled, tracked, or excavating equipment or log-dragging equipment in the bed" of a specified anadromous waterbody (quoted portions from AS 16.05.870(b)). All activities within or across a specified anadromous waterbody and all instream activities affecting a specified anadromous waterbody require approval from the ADF&G.

The ADF&G also provides comments and recommendations to federal agencies via the Fish and Wildlife Coordination Act (16 USC 661 et. seq.) and is a participant in the ADGC's "Coordinated Coastal Consistency Reviews".

Other Alaska Permits

As appropriate, other Alaska permits, licenses, and approvals may be required for the Kensington Gold Project. Such determination will be made through consultation with the ADGC.

LOCAL GOVERNMENT

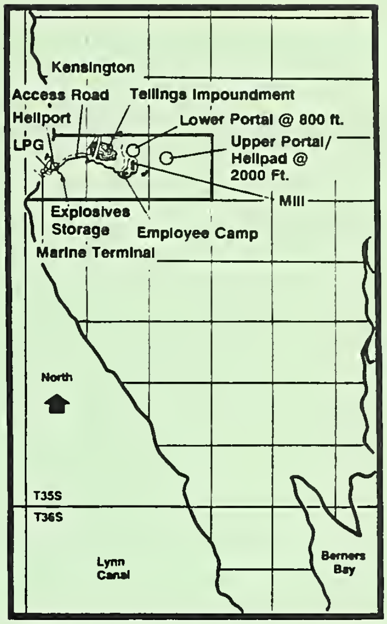
City and Borough of Juneau

The Kensington Gold Project is located within the CBJ. As such, the operation will be subject to all ordinances and regulations of the CBJ. These will include items such as obtaining a mining permit, grading permit, building permit, burning permit, and explosives handling permit.

Of primary importance for the Kensington Gold Project will be the submittal and approval of an Application for a Large Mine, complete with provisions for environmental control, reclamation, and financial warranty for the operation. The Applicant has prepared an initial Reclamation Plan which is included in Appendix A. The CBJ will also require an annual report on or before March 31 of each year describing the status of the mining operation in relation to the mining plan and timetable in the application as well as describing reclamation activities that occur during the year.

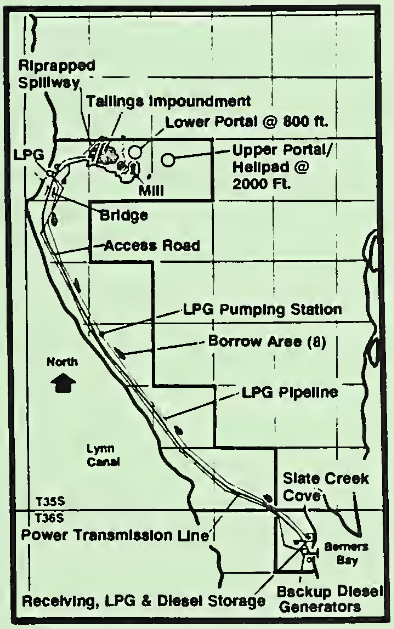
City and Borough of Haines

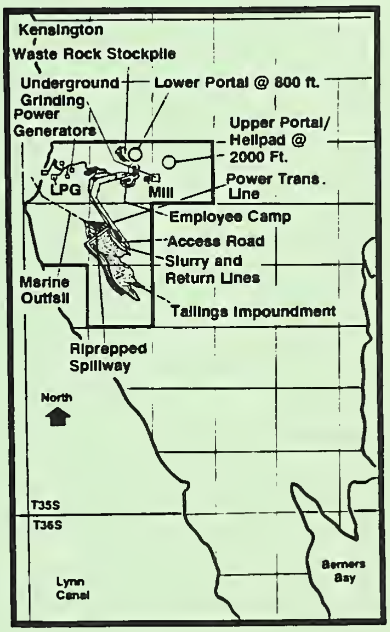
The Kensington Venture is outside the boundaries of the City of Haines and the Borough of Haines. The City and Borough have no current ordinances or regulations governing mineral exploration or mining although discussion is underway regarding development and implementation of mining ordinances.



CHAPTER TWO

ALTERNATIVES INCLUDING PROPOSED ACTION





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INTRODUCTION

On November 28, 1978 the Council on Environmental Quality issued the Final Regulatlons for Implementing NEPA (FR 55990, Col. 43, No. 230). In July 1978, the Forest Service issued Final Implementation Procedures for NEPA, which further define Forest Service procedures as related to NEPA. These regulations direct the Forest Service to apply uniform practices in developing a full range of reasonable alternatives for proposed developments on lands administered by the Forest Service, and impartially evaluate their effects on the environment.

This chapter describes the process used to develop and compare the Kensington Gold Project Applicant Proposal (*Appendix A, DEIS*) and five project alternatives, including the No Action Alternative.

The discussion of alternatives is the foundation of the EIS process (40 CFR 1502.14). There must be a reasonable array of alternatives to achieve the purpose for which an EIS is prepared.

Studies of metallurgical processing options and other project related tradeoffs were implemented by the Kensington Venture. This provided data related to process optimization, waste treatment needs, environmental safeguards and potential mitigation measures. This information was made available to the Forest Service early in the NEPA process.

Site visits were made to the project area by representatives of the Forest Service, other involved agencies, and the general public. These site visits provided individuals with a familiarity of the project area and additional insight regarding the variety of feasible component options.

COMPONENTS, OPTIONS, AND ALTERNATIVES

Components are separate elements which, joined together, form the complete project alternatives. This chapter provides descriptions of project components, including options to these components. The discussions of all proposed options, or combination of options, include those eliminated from further consideration and the reasoning for early elimination.

There are a number of separate operational components that must be linked to develop complete project alternatives for the Kensington Gold Project. For environmental analysis purposes, the overall mining and processing operation was segregated into major project components. These include:

- Mining methods
- Waste rock disposal
- Ore processing
- Wastewater treatment
- Tailings disposal
- Housing and other surface facilities and locations
- Access and transportation (supplies, work force)

Each of these components is analyzed in a similar fashion for all project alternatives. The selection of feasible component options for further consideration provides the basis for a compilation of a reasonable range of alternatives to the Applicant Proposal.

Geographic location, topography, extent of mineralization, and land ownership in the project area restrict certain options for each of the project components. For example, the location and extent of mineralization dictate the mine area.

The formulation of alternatives to the proposed project is significant in the NEPA process. Through the alternative development process, the agency can alter or lessen the magnitude of the potential effects of the proposed project on local environmental conditions.

A screening process was used to identify options or alternatives for the Kensington Gold Project. Although a number of options were formulated, many were screened from further consideration when they could not reasonably meet the proposal objectives or address the issues, particularly with respect to the avoidance or reduction of adverse

environmental impacts. The following alternatives were assembled from the options that survived the screening process.

- **Alternative A - No Action Alternative** - This alternative, required by NEPA, stops project development but allows continuation of mineral exploration. It provides a baseline against which action alternatives are compared.

- **Alternative B - Applicant Proposal** - This alternative locates tailings disposal in the Sherman Creek drainage. Project access for supplies would occur at a Comet Beach marine terminal facility. Helicopters would be used to transport employees. Onsite housing would be provided for employees. Crushing would be underground; grinding and milling would be above ground. The Ophir Creek diversion channel spillway into Sherman Creek below the dam would be concrete lined.

- **Alternative C - Berner Bay Access** - This alternative provides project access for employees and supplies from a marine terminal facility in Berners Bay at Slate Creek Cove. An 8.5 mile access road from Slate Creek Cove to the mine site in the Sherman Creek drainage would be constructed. No employee housing would be provided onsite. Enhanced settling would be used for wastewater treatment. The remaining facilities and tailings disposal are identical to Alternative B. The Ophir Creek diversion channel spillway would be riprap lined.

- **Alternative D - Sweeny Creek Tailings** - This alternative is identical to Alternative B except tailings would be pumped to a disposal impoundment in Sweeny Creek. Project access would be as Alternative B except that helicopters would fly from a base near Yankee Cove when transporting employees to the site. Grinding would be contained underground along with the crushing facilities. Diverted stream flows would be returned to Sweeny Creek below the dam via a riprapped lined channel. Enhanced settling would be used for wastewater treatment.

- **Alternative E - Dewatered Tailings** - This alternative is similar to Alternative B except that tailings disposal would be by the dewatered tailings method. A storage building would be required for temporary storage of tailings during wet weather when tailings could not be handled properly. Additional processing facilities for mechanical and thermal drying of tailings would be required to permit proper handling and placement. Hydrogen peroxide would be used for cyanide destruction.

- **Alternative F - Enhanced Effluent Treatment** - This alternative is similar to Alternative B, with two significant exceptions; the marine discharge line is routed along an alignment to the south of Point Sherman and there is additional treatment for effluent water.

Alternatives C, D and E were developed to address issues identified in scoping. Alternative F was developed in response to public comments and concerns expressed during the DEIS comment period. A summary of the issues and how they are addressed in each action alternative is presented in *Table 2-1, Development of Alternatives in Response to Issues*.

MITIGATION AND MANAGEMENT

Mitigation and environmental management guidelines as well as monitoring and control measures need to ensure that the final actions conform to all other applicable laws relating to the Forest Service activities. The intent of these constraints, guidelines, and mitigation measures is to ensure that adverse environmental impacts are avoided or minimized during construction, operation, and closure of the project.

Following completion of the NEPA process, the Kensington Venture would submit a Plan of Operations to the Forest Service. The plan would provide final engineering and detailed prescriptive mitigation measures, including a final reclamation and closure plan for the selected alternative.

Table 2-1, Development of Alternatives in Response to Issues

Issues	Alternative C Berners Bay	Alternative D Sweeny Creek	Alternative E Dewatered Tailings	Alternative F Enhanced Effluent Treatment
Address the social and economic impacts on the local residents in Juneau, Haines, and Skagway.	No difference from Alternative B	No difference from Alternative B	No difference from Alternative B	No difference from Alternative B
Maintain quality of existing fish habitats and minimize impacts to resident and anadromous fish which support commercial fisheries industry in Lynn Canal.	Access minimizes traffic in Lynn Canal	Tailings site moved to Sweeny Creek	Keeps tailings out of creeks	Marine discharge south of Pt. Sherman, different water treatment
Minimize disruption to marine traffic in Lynn Canal, especially commercial fishing.	Access minimizes traffic in Lynn Canal	No difference from Alternative B	No difference from Alternative B	Same as Alternative B, except reduced potential for anchor fouling
Maintain the integrity of affected watersheds by minimizing impacts to water quality and maintaining proper flows.	Increased risk of accidental spills on land due to increased pipeline and transport distances	Disturbance in two drainages	Keeps tailings out of creeks, confines disturbance to one drainage	No difference from Alternative B
Minimize disruption to recreation opportunities.	Highest potential for disturbance to recreation in Berners Bay	Disturbance in two drainages	Confines disturbance to one drainage	No difference from Alternative B
Minimize visual impacts of the operation from Lynn Canal and Berners Bay.	Highest potential for visual impacts in Berners Bay	Tailings Dam is less visible from Lynn Canal	Highest potential for visual impacts in Lynn Canal during operation	No difference from Alternative B
Minimize disturbance by maintaining a compact operation.	Largest amount of surface disturbance	Disturbance in two drainages	Smallest disturbance for tailings disposal	No difference from Alternative B
Minimize disruption to wildlife and wildlife habitats.	Greatest potential for disturbance to bald eagle nest sites and estuarine habitats	Tailings location and underground grinding minimize activity and disturbance in mountain goat habitat	Noise from dry tailings disposal has highest potential to impact mountain goat habitat (Site A)	No difference from Alternative B
Identify subsistence resources and level of use within the project area.	No difference from Alternative B	No difference from Alternative B	Minimizes loss of stream habitat	No difference from Alternative B
Address the cumulative impacts of this and other potential development projects	Allows for joint use of access	Allows expansion for joint use of tailings	No options for joint facilities use	No difference from Alternative B
Minimize chances of system failure by incorporating technically feasible component siting, design, and mitigating features.	Access avoids Lynn Canal weather conditions	No difference from Alternative B	Tailings not exposed to potential stream channel erosion and dam failure	No difference from Alternative B

ALTERNATIVE COMPARISON

Project alternatives are compared. The comparison is derived from evaluations of significant issues associated with each alternative.

PROJECT COMPONENT OPTIONS STUDIED IN DETAIL

The Kensington Venture has proposed a project that would consist of an underground mine, an ore processing facility, a tailings impoundment, an office and maintenance complex, an employee camp, one heliport and two helipads, a marine terminal, and other ancillary facilities. These include an access road between the marine terminal and the mine, fuel storage area, and an explosives magazine. All such facilities would be contained within the Sherman Creek drainage. (*See Figure 2-1, Applicant Proposal Site Layout*).

per day. This rate is based on current ore reserves and mining economics.

The following discussions summarize a reasonable range of options for each operational component. Project alternatives were developed by assembling these components into groups.

PROJECT LOCATION

There are no feasible location alternatives for the proposed mine area. The location of the defined ore deposit necessarily controls the location of the mine. The geology and mineral deposits associated with the Kensington Project have been extensively explored and studied since the early 1980s.

Underground mining might allow accessing the deposit from a different location or elevation. However, the existing underground access facilities would accommodate primary access to the ore deposit(s). The helipads, located at the main facilities area and the upper portal, are for emergency use and intermittent maintenance. The upper pad is especially needed as there is no road to the upper portal and access is limited. These accesses would also serve ventilation and emergency escape requirements.

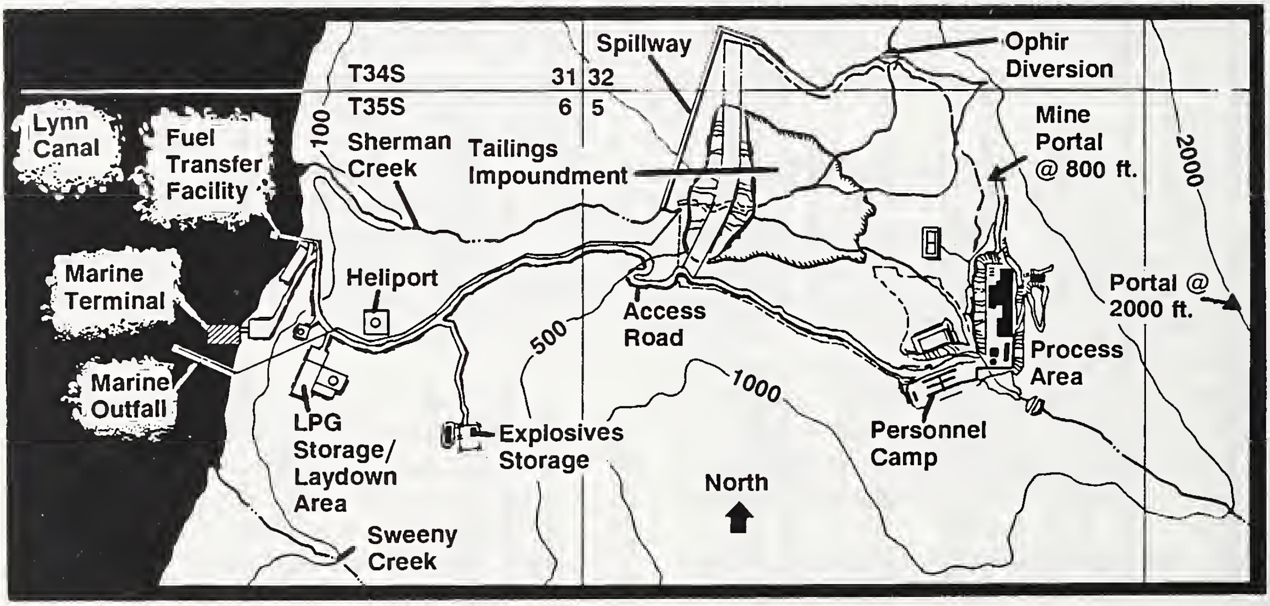


Figure 2-1, Applicant Proposal Site Layout

The proposed operation has a projected life of at least 12 years once the mine is put into full production. Construction activities would take approximately 2 years.

During full operation, the proposed project would process approximately 4,000 tons of ore

MINING METHODS

There are a number of proven mineral extraction techniques which have been used in hard rock mining. Any number of extraction techniques, or variations on techniques could be used to mine the Kensington ore body. Selecting the most practicable mining method is a complex process involving consideration of a number of factors such as:

- The spatial characteristics of the deposit (size, shape, attitude, and depth)
- The physical properties of the mineral deposit and the surrounding rock
- Groundwater and hydraulic conditions
- Economic factors, including grade of the ore, comparative mining costs, and desired production rates
- Environmental factors such as prevention of air and water pollution

Of these factors, the spatial characteristics of the deposit and the physical properties of the mineral and surrounding rock are usually the limiting factors in selection of a mining method. Any mine design for the Kensington Project must be based on geologic conditions and rock mechanics data relating to the ore body characteristics.

Geology and Nature of Ore Deposit

The host rock is strong and relatively free of fractures. The ore zone consists of a dense pattern of veins and veinlets which extends from surface to approximately 3,000 feet underground and is open at depth. The ore zone varies in width from 22 feet to over 165 feet and averages approximately 60 feet. The ore body is irregular and erratic in shape and gold value distribution. Waste, or sub-economic material, separates the mineralized areas.

The selected mining method must be responsive to a relatively wide, competent ore body which exhibits no correlation with structure or alteration zones. A recovery method which can efficiently recover gold from waste and sub-economic zones is essential given that selective mining would not be practical. Fill would not be required to support the ground where stopes are 165 feet in length and 375 feet in height (Redpath, 1990).

Generally, a limited number of options are available in the selection of a mining method. The Applicant Proposal describes an underground extraction technique called long hole, open stoping.

Long Hole, Open Stoping

The mine would be accessed by an adit approximately 1 mile in length. This mining method is used where the ore occurs in steeply dipping, wide vein deposits. This method requires strong ore and wall rock to support the stope without additional mechanical roof control. Open stoping is flexible and able to respond to irregular ore widths. It efficiently removes ore while providing for separation of waste necessary to ensure a high rate of resource recovery (80 to 90 percent). Dilution of ore is minimal. The method uses bulk material handling for higher productivity. Mining would proceed from the top of the ore body downward.

The method incorporates high worker safety by limiting exposure to unsupported ground conditions. The method also provides for good ventilation. Underground personnel requirements and associated supervision and technical support have been estimated to be 140 persons for long hole, open stoping at the proposed production rate.

Future development can be safely completed along strike and dip to recover additional undiscovered ore. The recovery of pillars by mass blasting would cause the hanging wall to cave and would also relieve stress on adjoining workings. Subsidence at the surface is not expected due to the bulking effect of the broken material and the minimum 150 foot crown pillar which would be left to ensure stability (Redpath, 1990).

The nature of the ore body and characteristics of the long hole, open stoping mining method are compatible to make the recovery of the ore body feasible. In addition, safe working conditions and a minimal work force would ensure that the ore body is recovered with the least risk to workers. The minimal work force would also reduce support facility size requirements. (See *Figure 2-2, Long Hole, Open Stoping Mining Method*).

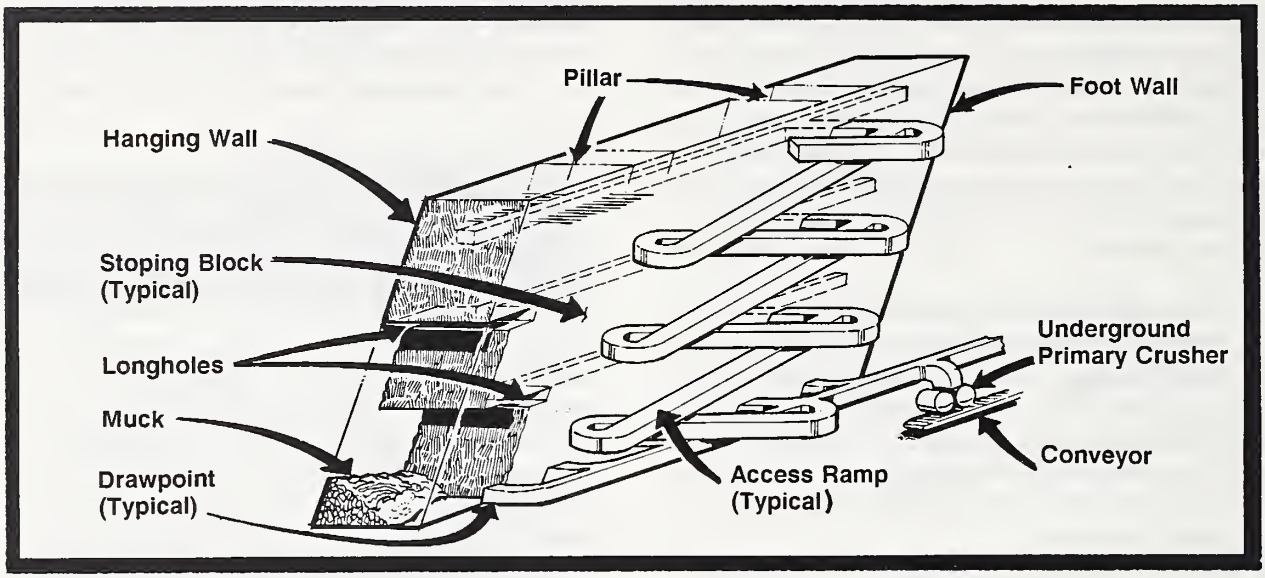


Figure 2-2, Long Hole, Open Stoping Mining Method

WASTE ROCK DISPOSAL

Disposal of underground development waste rock is essential to mining. This material consists of rock with a gold content below the economic processing grade. Disposal must be accomplished at a stable and suitable site.

The Applicant Proposal anticipates the production of approximately 400 tons (270 loose cubic yards) of waste rock per day. The rock would be mined and hauled to the surface in diesel-powered haul trucks.

Waste rock would be placed on the surface near the mine portal where it would be available for construction of the tailings pond embankment, roads, or the foundations for other facilities. Waste rock would also be used for the maintenance of surface and underground roads.

At the proposed levels of production, approximately 150,000 tons or 100,000 cubic yards of waste rock would be produced each year. The projected total waste rock for the life of mine is estimated to be about 1,200,000 cubic yards. Limited quantities could be used during initial project development since construction would precede underground development. The waste rock would be stockpiled at a temporary or permanent site depending on the preferred alternative.

The waste rock may require crushing and/or sizing to be used for road and embankment material. Approximately 10,000 cubic yards would be used each year in maintenance of surface and underground roads. Maintenance would include spring breakup repair, fall repair, and winter sanding of surface roads.

Stockpile volumes would be different depending on the alternative selected. Road maintenance would consume approximately 120,000 cubic yards over the mine life. More would be used in the case of the Berners Bay access road. The remaining waste, 1,080,000 cubic yards, must be either temporarily stockpiled and utilized throughout the mine life in tailings dam construction, or placed in a permanent waste rock disposal site. Dewatered tailings disposal would utilize a significant amount of waste rock in the construction of an embankment buttress and haul roads.

Construction of the Sherman Creek tailings pond would require approximately 927,000 cubic yards of waste rock to complete raises on the embankment during the life of the mine after completion of the starter dam. Any remaining material could be used in reclamation of the

project area or as riprap (Dames & Moore, 1989c).

The Sweeny Creek tailings impoundment site is located approximately 2 miles from the mine site. Starter dam construction would require material from a quarry near the site. Due to unfavorable topography In the impoundment area, the quarry would be located adjacent to the dam site. As available, waste rock would be hauled and used In constructing subsequent dam raises. The large quantities of material required for dam construction would not be generated quickly enough from mine waste, therefore, quarry material would be required. The mine waste production timing (schedule) would require about 612,000 cubic yards be placed in a permanent waste rock disposal site (Dames & Moore, 1989c).

The dewatered tailings placement option would consume most of the waste rock in constructing the tailings disposal facility.

ORE PROCESSING

Milling is the process of separating gold from the undesired or non-economic mineral matter. For the Kensington Gold Project, the Applicant proposes to use underground crushing facilities to prepare ore for feed into the surface grinding, flotation, and concentrate cyanidation circuits. Other options for ore processing locations and methods are presented in this section.

Processing involves several circuits including the following which occur sequentially after ore is mined and transported to the crushing facilities. The circuits are:

- Crushing
- Grinding
- Flotation and Cyanidation
- Gold Recovery
- Cyanide Destruction

Underground Crushing Facilities

The Applicant proposes that ore would be crushed in an underground facility. Crushed ore would be conveyed to the surface for processing and gold extraction. In this option, ore would be crushed to less than 6 inches in size before being brought to the surface (DMC, 1990b).

Ore would be delivered by mine vehicles, trucks, or an ore pass system to a crusher feed bin. The feed bin would be sized to hold 500 tons of ore. Ore would be reclaimed by a feeder discharging to a jaw crusher and belt conveyor. After passing through the crusher, crushed rock would be conveyed to an 8,000 ton ore stockpile on the surface. An 18 foot wide by 16 foot high conveyor tunnel, 4,600 feet long, would house the conveyor from the crusher to the surface (DMC, 1990b).

Placement of the crushing facilities underground minimizes land use disturbance and makes the operation more compact.

Underground Grinding Facilities

Underground grinding would involve excavation of an area large enough to accommodate the grinding equipment and mill feed storage near the crusher. The mill feed storage would involve an excavation of 30 by 50 by 110 feet connected to the grinding excavation by two 16 by 18 foot drifts. The grinding excavation would be approximately 130 by 150 by 70 feet. These excavations would be connected by access drifts, ventilation drifts, ore passes for ore, supplies and equipment, and personnel transport (Bechtel, 1991).

The grinding circuit is comprised of a semi autogenous grinding (SAG) mill operating in closed circuit with a horizontal vibrating screen and a ball mill operating in closed circuit with hydrocyclones. The SAG mill would be about 24 feet in diameter and 10 feet long. The ball mill would be about 14 feet in diameter and 22 feet long. A series of 2,500 horsepower (approximate rating) synchronous motors would power these mills. The vibrating screen and hydrocyclone would control the size of solid particles in the ground ore slurry. The facility would include an overhead bridge crane for maintenance.

Ore is passed through the ball mill and exits the hydrocyclones as a slurry. The slurry is then pumped to the flotation circuit. Two slurry lines would be required for maintenance and as a backup system. The slurry lines would be

located In the inclIne (conveyor tunnel) from the crusher and grinding station to the surface.

Surface Grinding Facilities

The Applicant proposes to construct the milling facility above ground. The grinding circuit would be located in a 90 by 100 foot steel frame building next to the flotation building. The same SAG mill/ball mill arrangement described for underground grinding would be used in the circuit. Ore would be routed by conveyor from the underground crusher to the surface stockpile. From the surface stockpile, ore would be discharged to a conveyor feeding the SAG mill.

Surface Flotation and Cyanidation Facilities

The flotation process involves separating the gold containing minerals from the barren rock by froth flotation. In this process, the conditioner overflow would feed a series of flotation cells. Chemical collectors and frothing agents are added to the conditioner.

The flotation concentrates are pumped to a tower regrind mill which grinds the concentrates to a smaller size. The overflow from the regrind mill flows by gravity to a concentrate thickener for dewatering prior to leaching.

The flotation cells, pumps, and regrind mill would be housed in a steel-framed building. The mill water tank and concentrate thickener would be located outside and west of the flotation bay.

Measures must be taken to contain the tanks and prevent escape of solutions. On the surface, adequate room exists to work and to effectively monitor all solution handling systems. There are numerous safety concerns relative to cyanide use. Less labor, safer operations, and ease of monitoring make the surface flotation and cyanidation facility location considerably more feasible than underground siting.

Conventional Milling Using Flotation and Tank Cyanidation

The Applicant has conducted large-scale pilot testing to evaluate the chemical and physical properties of the Kensington ore and has determined that a conventional mill using flotation followed by tank cyanidation of the flotation concentrates is the most feasible method of ore processing. Using these methods, ore processing would occur within enclosed and/or contained structures.

Flotation. The Kensington Venture has proposed a flotation concentration process which would separate and remove approximately 93 to 96 percent of the non-gold material from the mill feed of 4,000 tons of ore per day. The remaining 4 to 7 percent (an estimated 160 to 280 tons) of flotation concentrate would be introduced to the cyanide leach process each day. Flotation is a distinct process which occurs after grinding and prior to any cyanidation.

Ore from the grinding circuit would be passed through a series of flotation columns, where sulfide and telluride minerals containing gold are recovered by froth flotation. Froth flotation is a method of concentration in which the effective specific gravity of selected minerals are substantially decreased by air bubbles which attach to particles of that particular mineral. The sensitized mineral particles float on a separating medium while the unaffected particles sink. Concentrates and tailings are produced in this process. Following this portion of the process, ore is processed by tank cyanidation to extract gold.

Tank Cyanidation. Flotation concentrates are pumped from the flotation circuit to a regrind circuit in order to reduce particle size and liberate the gold. The fine material flows to the concentrate thickener for dewatering prior to leaching. (*See Figure 2-3, Tank Cyanidation*).

From the concentrate thickener, concentrates are fed into agitated pre-aeration tanks. Low pressure air is introduced into the tanks to oxidize cyanide consuming components and provide conditioning time. This reduces the amount of cyanide required for leaching. A lime slurry is added to maintain a pH greater than 12 as the concentrates move into a series of tanks where cyanide is added. A high pH is needed to prevent the cyanide from volatilizing into the air as hydrogen cyanide. Approximately 25 to 30 pounds of lime would be used per ton of concentrate (2 to 4 tons of lime per day) for pH

control. Additional information on reagent use can be found in Appendix A.

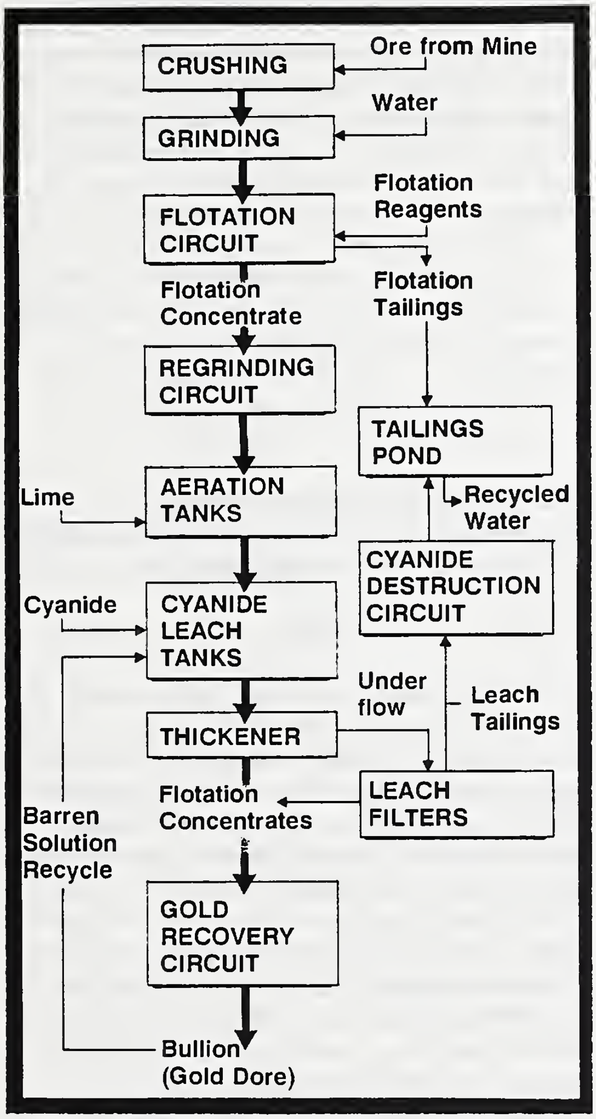


Figure 2-3, Tank Cyanidation

The ore slurry is pumped from the pre-aeration tanks into a series of agitated leach tanks where a solution containing dissolved cyanide is added to the slurry. Sodium cyanide usage would depend on the concentrate grade, and may vary from 2 to 5 pounds per ton of concentrate.

As the ore moves through the leach tanks, sodium cyanide solution in the presence of oxygen dissolves the gold. The slurry passes through the tanks and, after all the gold has been dissolved and adsorbed by the activated carbon, is discharged to the cyanide destruction circuit. Here cyanide is destroyed by the alkaline chlorination process. Leach tailings are then combined with the pre-cyanidation flotation tailings described earlier and pumped to the tailings pond.

Gold Recovery

The carbon-in-leach process involves pumping slurry concentrate through a series of tanks with activated carbon. (*See Figure 2-4, Carbon Adsorption Gold Recovery*). Activated carbon adsorbs the dissolved gold from solution. As the carbon becomes loaded with gold, it is transferred to a precious metal stripping circuit.

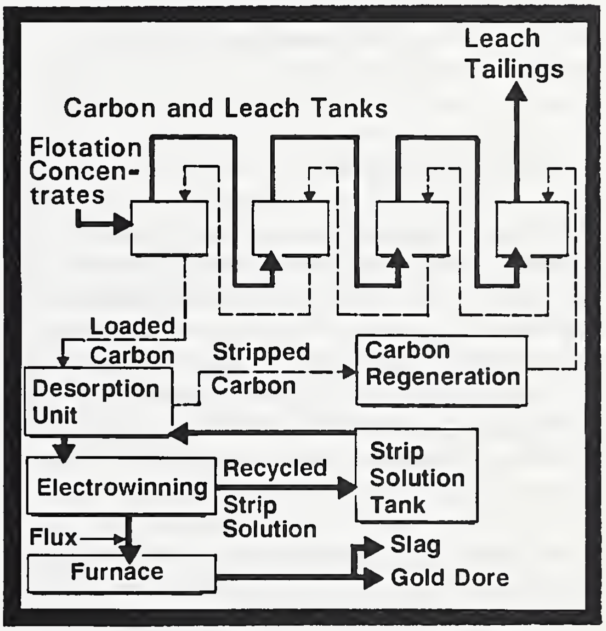


Figure 2-4, Carbon Adsorption Gold Recovery

The stripping circuit consists of a tank which holds the loaded carbon. Hot (120° C) cyanide solution is passed through the stripping vessel to desorb the previously adsorbed metal/cyanide complexes from the carbon. The stripping solution is then passed through an electrolytic cell using steel wool as a cathode for deposition of gold.

The cathodes from the electrolytic cell are transferred to a furnace where fluxes are added which cause gold to separate from slag as the furnace charge melts. The charge is poured into a conical slag pot where gold settles to the

bottom and Is recovered as a button. The button is re-melted for casting into ingots and shipment to a refinery. The stripped carbon is washed and regenerated in a reactivation kiln before being returned to the adsorption circuit. The process is a closed circuit with no process solution lost or discharged to the environment.

MILL WASTEWATER TREATMENT

Wastewater treatment would involve two distinct process phases. The first phase would destroy excess cyanide prior to disposal of tailings. The second phase would reduce metals and suspended solids levels in the wastewater stream.

It should be noted that wastewater will be treated to levels required to meet NPDES and Alaska water quality standards. This EIS displays different methods of achieving these levels.

Cyanide Destruction

The goal of cyanide destruction is to lower cyanide levels in the tailings to regulatory approved levels and remove toxic cyanide from the effluent stream so that any discharge from the tailings pond meets the discharge standards of both EPA and the ADEC. Regardless of the technique used for chemical destruction of cyanide, those discharge standards must be met.

Most common cyanide treatment processes use oxidizing agents in combination with pH control to eliminate cyanide and metal-cyanide complexes from solution. Historically, alkaline chlorination is by far the most common (in terms of numbers of installations) process because it is simple to operate, reliable and because chlorine has been relatively inexpensive and commercially available in most areas for almost 100 years. Other treatment processes have been utilized on a more limited basis or evaluated at the bench and pilot scale. Three processes (natural degradation, alkaline chlorination and hydrogen peroxide) are considered in detail in the FEIS.

Natural Degradation. The natural degradation of cyanide is a passive treatment mechanism that involves natural conditions of sunlight, atmospheric oxidation, temperature/ volatilization and biological activity. These processes are known to significantly reduce the concentration of cyanide in a tailings pond. However, they are essentially uncontrolled and constantly changing environmental conditions make it difficult to accurately predict site specific effectiveness (JMM, 1992). Under aerobic conditions, the biodegradation of cyanide involves the formation of cyanate, as follows:

$$HCN + 1/2\ 2O_2 \text{ -----> } HCNO$$

Cyanate is hydrologized according to the equation:

$$HCNO + H_2O \text{ -----> } CO_2 + NH_3$$

A suggested pathway for the anaerobic decomposition of cyanide leads to the formation of thiocyanide followed by hydrolosis:

$$HCN + S \text{ -----> } HCNS$$

$$HCNS + 2H_2O \text{ -----> } H_2S + CO_2 + NH_3$$

Pond geometry influences the rate of decomposition. Research on decomposition rates showed that decomposition in deeper pond areas lags decomposition in shallow pond areas by 35 to 40 days.

Alkaline Chlorination. The Applicant has proposed alkaline chlorination as a cyanide treatment process. Using this process, the destruction of free cyanide occurs in three stages. The first step results in the rapid formation of cyanogen chloride, a reaction which is not pH dependant:

$$NaCN + Cl_2 \text{ -----> } CNCl + NaCl$$

In the second step, cyanogen chloride decomposes to cyanate:

$$2CNCl + 2Ca(OH)_2 \text{ -----> } Ca\ (CNO)_2 + CaCl_2 + 2H_2O$$

Cyanogen chloride is a highly toxic compound that can be liberated from solution as a gas when the pH falls below 10, hence the necessity to carry out the reaction in an alkaline environment. The resulting cyanate ion (CNO^-)

is reportedly less than 1/1000 as toxic as the free cyanide ion (Scott, 1985), and cyanates are not generally listed as wastes to be controlled in discharge regulations. However, it is possible for the cyanate ion to be reduced back to cyanide under anaerobic conditions, and for this reason the final stage of decomposition should be applied, in order to completely stabilize the cyanide ion.

The third stage of the reaction is enhanced at a pH of approximately 8.5 . According to the equation, further oxidation of cyanate to nitrogen and carbon dioxide is accomplished.

$$3Cl_2 + 2CaCNO + 6\ NaOH \text{ -----> } 2NaHCO_3 + N_2 + 6CaCl + 2H_2O$$

In water the residual cyanate (as cyanic acid HNCO) can hydrolyze further to produce carbon dioxide and ammonia.

$$HCHO + H_2O \text{ ----> } NH_3 + CO_2$$

This reaction is pH dependent and occurs at pH up to 8.5. It is accelerated at lower pH values. Further oxidation of ammonia will occur to form nitrate and nitrogen.

The first stage, assuming only uncomplexed free cyanide, has a theoretical reaction time of about 15 minutes. However, complexed cyanide can take up to 60 to 90 minutes to react. The second stage reaction time is 15 to 20 minutes. The final stage occurs under natural conditions over a period of days.

Chlorine will oxidize many substances other than cyanide. Organic substances, thiocyanate, thiosalts and metals in low oxidation states can all contribute to the overall chlorine demand. Theoretically, 2.7 lbs of Cl2 to CN- is necessary due to the presence of other oxidizable substances, but this is site dependent. Thiocyanide can require two to four times as much chlorine to destroy as cyanide alone, and is preferentially destroyed before any free cyanide is destroyed (Devuyst, et.al. 1985, Du Pont, 1981). Wastes high in thiocyanide can cause the use of large quantities of chlorine.

The alkaline chlorination method also results in the precipitation of metal hydroxides from solution. Under the high alkaline conditions of the reaction, metals precipitate from solution as metal hydroxides, including metals once complexed with cyanide. The generalized form of the equation is represented as:

$$Me{+}X + XOH^- \underset{\text{<-----}}{\text{----->}} Me(OH)x$$

Where Me+ is the metal ion in solution.

The Applicant evaluated the effectiveness of the alkaline chlorination process for treating cyanide leach effluent solution resulting from metallurgic testing (Lakefield 1988 and 1990).

The tests indicated that the Kensington samples were treatable by alkaline chlorine oxidation and that total cyanide reductions of approximately 99 percent could be achieved.

Process options using alkaline chlorination may require dechlorination as an added step to wastewater treatment. Dechlorination is commonly used when chlorine in the effluent stream is a concern. The process is generally very effective in removing chlorine to undetectable levels.

Hydrogen Peroxide. The use of hydrogen peroxide as an oxidizing agent has several advantages. It decomposes to the harmless products oxygen and water, and it does not cause increased levels of dissolved solids or salts. The reaction with cyanide occurs in a single step reaction to form cyanate:

$$CN^- + H_2O_2 \text{ -----> } OCN^- + H_2O$$

The metal ions liberated by the dissociation of cyanide complexes are precipitated as hydroxides if the pH is in the 10 to 11 range. The rate of reaction of the cyanide oxidation is governed, to a large extent, by the rate of dissociation of the metal complexes, and to a lesser extent on the amount of hydrogen peroxide present. Iron cyanides are not oxidized by hydrogen peroxide, but instead will form a precipitate with heavy metal ions in solution, especially copper.

The cyanate ion reacts further with hydrogen peroxide to form the ammonium ion:

$$OCN^- + 2H_2O_2 \text{ ----> } CO3^{--} + NH_4^+$$

Hydrogen peroxide reacts with many other substances in water, including sulfides, thiocyanates, organic substances, and metals in low oxidation states. The hydrogen peroxide demand in the waste stream being treated tends to be variable, and must be carefully monitored to avoid over-dosing of the oxidant.

A report on testing conducted by the Degussa Corporation (1988) concluded that while hydrogen peroxide was effective in treating filtered solution from the leach process, treatment of the pulps (solids) in solution as proposed, resulted in extremely high reagent dosage to achieve 98+ percent cyanide (measured as WAD cyanide during these tests) removal. The high peroxide demand (10 times the clean barren solution) was attributed to the highly oxidized pyrrhotite ores characteristic of the samples.

The economics of hydrogen peroxide treatment are usually less favorable than alkaline chlorination, but several factors may cause hydrogen peroxide to be favored. The following factors can influence the ability to use hydrogen peroxide for cyanide destruction.

- **Presence of thiocyanides.** Thiocyanides are preferentially destroyed by alkaline chlorination, resulting in significant chlorine demand for a compound that generally does not need to be destroyed. Peroxide reacts with thiocyanide at such a slow rate that in practice less than 15 percent of the thiocyanide is destroyed.

- **Presence of ferrocyanides.** Ferrocyanides can be oxidized by chlorine to ferricyanides, which remain in solution under typical operating conditions and add to the total cyanide concentration.

- **pH control.** The peroxide process is not pH dependent, so no chemicals or feed equipment is necessary for pH control.

- **Chloride or sulfate buildup.** The alkaline chlorination and SO2/air process can result in the addition of chlorides and sulfate to the treated waste stream. In cases where chloride buildup is a problem, the peroxide process may be advantageous because it does not itself cause the buildup of any salts.

It has not been used extensively to treat mine wastes at large operations because of economic considerations. However, in 1984 OK TEDI Mining Limited began using hydrogen peroxide to treat the wastewater from their Paupa, New Quinea gold mine. Hydrogen peroxide was used because it was felt by the owner that it had the ability to meet the very stringent effluent requirements in Paupa, New Guinea. More recently the use of hydrogen peroxide has enjoyed acceptance at a number of smaller mining operations because of its ease of handling and perceived operator safety advantages over chlorine. The Greens Creek mine on Admiralty Island currently uses this process for cyanide destruction.

Wastewater Treatment for Metals and Suspended Solids

A qualitative comparison of available wastewater treatment processes for mining and milling application must be based upon the specific characteristics of the waste to be treated and the effluent criteria set by the NPDES permitting process.

Chapter 4 displays the advantages, in terms of effluent quality that could be expected from using several different processes. The goal of wastewater treatment would be to insure that NPDES permit limits and receiving water quality standards are met by the Kensington Venture. As the NPDES Permit is developed, other wastewater treatment methods could be considered as long as the objectives are met.

The laboratory data and water quality analysis prepared for the Kensington Project indicate that the potential effluent water quality parameters of concern, other than cyanide, include metals and total suspended solids. The following discussion concentrates on treatment processes targeted for those parameters.

The practical alternative methods for suspended solids reduction include basic pond settling as

proposed by the applicant, enhanced pond settling, filtration, and chemical precipitation followed by solids removal. Reported effectiveness, equipment availability, and reliability were the primary factors in this determination.

Basic Pond Settling. Settling in the tailings pond is proposed by the applicant as treatment for metals and suspended solids. Detention time would be 2 days.

Enhanced Pond Settling. Certain measures could be used to improve wastewater effluent quality from the existing system. Flocculants could be added at the mill and thoroughly mixed into the effluent stream. They would agglomerate the smaller solid particles allowing more rapid settling. This enhanced settling could be combined with improvements for the management of the pond hydraulics to improve in pond settling conditions and avoid solid discharges. Modifications such as floating baffles, discharge control structure, weir control, and careful monitoring of effluent discharge flow could extend detention time and improve effluent quality.

Chemical flocculants could include natural and synthetic polymers, coagulants such as lime, alum and ferric salts (all commonly used in domestic water treatment). These can act to both precipitate dissolved metals and enhance solids removal in the pond.

Filtration. Filtration is a physical process that can effectively remove suspended particulate solids in water. Filtration could be applied to any process flow, however, particular to the Kensington Project would be its application following chemical treatment of the cyanide leach circuit effluent or the filtration of the tailings pond effluent.

Filtration achieves two primary objectives, removal of inert suspended solids (nonsettling silts and fines) and removal of precipitated metals (hydroxides and sulfates) that will form during ore processing and subsequent alkaline chlorination.

Filtration efficiency as high as 95 percent could be expected for particle sizes above 25 microns. Since the majority (up to 99 percent) of the total metals present in the tailings pond are anticipated to be in the particulate solid form (greater than 25 microns), filtration would provide a very effective method for total metals removal.

The filtration process for this application would involve the use of rapid sand or sand/anthracite filter media which would effectively sieve the suspended solids from the process flow, allowing only very small particles to pass through the filter media. Chemical pretreatment can be employed to precondition the filter influent flow for improved removal, however, the effectiveness of chemical pretreatment would have to be determined by laboratory testing.

Solids removed as a result of filtration must be backwashed from the media when the media surface becomes impacted (dirty) to continue to process the required flow. The backwash water containing the filtered solids must be further treated to dewater and stabilize the solid fraction. While a number of filter backwash treatment alternatives are available, one possible option is to dewater the solids and dispose of the stabilized material back into worked out areas of the mine. Filter backwash dry solids volume should, under worst case conditions, be less than 0.01 percent of the ore processed volume.

Chemical Precipitation and Settling. Chemical precipitation is a widely used and well developed technology in the water treatment field and has been applied to lesser degrees in municipal and industrial wastewaters. Chemical precipitation is a physical/chemical treatment method that separates and removes metallic contaminants by altering the ionic equilibrium of a metallic compound to produce an insoluble precipitate that can be isolated.

The solubility of metallic compounds is primarily influenced by the pH. Thus, the first step in a mine/mill wastewater precipitation process is a pH control system that adjusts the pH to the level required to precipitate the optimal quantity of contaminant metal salt. The minimum solubility for most compounds is in the pH range of 9 to 11. Effective copper removal occurs in a pH range of 8.5 to 9.5 and may require a two-stage reaction.

In order to be more effective, the process requires pretreatment to separate the leached solids (ore) from the solution portion and treatment of the solution to destroy free and metal complexed cyanides. This can be done most effectively by dewatering the solution from the leached ore and treating the liquid phase in a precipitation reactor and settling tank. A wide variety of treatment options and configurations are available. Pilot studies would determine the degree of pretreatment.

Several commercial reagents are available to maintain alkaline conditions. These chemicals (*See Table 2-2, Chemical and Reagent Use*) can be divided in three forms:

- hydroxides (lime, caustic soda)
- sulfides
- carbonates (soda ash, limestone)

precipitation process will center on the use of lime as the reagent.

After pH adjustment of the wastewater metal precipitates are settled out or filtered to produce a sludge that can be further dried or dewatered prior to disposal.

Settling or filtering is followed by neutralization with an acid or dilution of the treated waste stream to a final pH that enables the process to meet the treatment and discharge objectives. Carbon dioxide or sulfuric acid are generally used as the final neutralizing agent.

The effectiveness of lime precipitation to remove metals is dependent on the oxidation states of the metals in the wastewater and the solubility of these various forms. Lime precipitation becomes less effective as the metal

Table 2-2, Chemical and Reagent Use

Milling Process	Reagent or Material	Container (Shipping & Storage)	Approximate Daily Use (tons)
Grinding	Steel Balls	10 ton steel bins	5-6
Flotation	Pine Oil Frother	50 gal drum	0.4
	Potassium Amyl Xanthate	50 gal drum	1
	MIBC (Frother)	50 gal drum	0.4
	Flocculent	1 ton Flo-bin	0.2
	Lead Nitrate	1 ton Flo-bin	0.03
	Polymer	50 gal drum	0.02
	Surfactant	50 gal drum	0.04
	Scale Inhibitor	50 gal drum	0.1
Cyanidation	Lime	Bulk Containers	2-3
	Sodium Cyanide	16 ton ISO Containers	0.4-1.4
	Carbon	Bulk Containers	0.8-2.1
	Sodium Hydroxide	50 gal drum	0.2-0.4
	Sulfuric Acid	50 gal drum	0.01-0.07
	Flux (sodium nitrate, borax, silica)	1 ton Flo-bin	0.01-0.07
Cyanide Destruction	Chlorine	1 ton Containers	4-5

Each chemical has varying degrees of treatment effectiveness and specific characteristics. Lime is the most commonly used reagent and most of the metal removal data reported in the literature involved lime precipitation. Therefore, subsequent discussion of the chemical

concentrations decrease, and at lower metal ion concentrations the removal mechanism becomes less efficient.

Lime precipitation is generally effective (70 to 90+ percent) for the removal of copper and

lead. Lime precipitation alone is not as effective (50± percent) for the removal of nickel or arsenic.

Removal effectiveness for some metals is dependent on their respective oxidation states. Because the treatment facility cannot directly control the influent conditions, the effectiveness of the metals removal process could be affected. If metals removal at Kensington were required, pilot testing would be necessary to verify the performance of chemical precipitation.

TAILINGS DISPOSAL

Tailings are the finely ground, sand and silt-like waste rock material which are the by-product of milling (ore processing). Tailings consist of rejects from the flotation circuit and leach residue from the cyanide destruction circuit.

At present, the Applicant is estimating at least a 20 million ton ore reserve. Ongoing preliminary design is being conducted to accommodate up to 30 million tons of tailings at the alternative tailings disposal sites. The probability of delineating an ore reserve of 20 million tons is high based on the existing defined reserve. As all ore mined becomes tailings after processing, sufficient tailings disposal areas are required for the expected recoverable ore body. Following is a discussion of the tailings options identified for the Kensington Project.

Conventional (Wet) Tailings Disposal

Tailings would be transported as a slurry to a disposal site. Water used in the process would be recycled to the extent possible, depending on the season and the amount of precipitation falling on the tailings pond.

The Applicant proposes to pump tailings from the mill to the tailings impoundment using an 8 inch diameter slurry pipeline. The tailings slurry would contain approximately 29 percent solids by weight. Once solids settle out from process water in the tailings pond, process water would be available for recycling. Process water and precipitation would be returned to the mill by a barge-mounted pump located in the center area of the tailings pond. Slurry and return water pipelines would be constructed utilizing flexible pipe resistant to corrosion and abrasion.

Tailings would be discharged around the perimeter of the active tailings areas to form a beach using a managed thin-layer deposition technique. This method of deposition allows coarser materials to settle out close to the embankment, while fines are transported to the center portions of the impoundment for settling.

Composite tailings samples produced as a result of bench scale and bulk metallurgical testing of the ore have been subject to corrosive, reactivity, and EP toxicity tests. These tests show that the tailings material does not contain any anomalous or deleterious concentrations of heavy metals or other materials characterized by these tests. The tailings would not be classified as hazardous waste under current RCRA regulations. Excess water accumulated in the tailings impoundment as a result of net precipitation buildup would be discharged to Lynn Canal via a marine outfall in accordance with an EPA administered NPDES Permit. Locational options for conventional disposal would include the Sherman Creek and Sweeny Creek sites with nearshore and deep water marine outfall locations incorporated as options for both alternatives.

Sherman Creek. The Kensington Venture has proposed an onshore tailings disposal facility in Sherman Creek downstream of the confluence with Ophir Creek. Initially, a starter dam would be constructed from both underground development rock and rock material obtained from a surface borrow area within the impoundment area.

Review of the dam design would be conducted by the Forest Service and the City and Borough of Juneau. The final design approval would be provided by the Alaska Department of Natural Resources dam safety engineer.

The starter dam would be located and constructed across a constricted section of Sherman Creek. The dam would begin at a toe elevation of approximately 410 feet Mean Sea Level (MSL) and extend to an intermediate crest elevation of approximately 570 feet MSL giving an initial dam height of 160 feet. (See *Figure 2-5, Sherman Creek Tailings Disposal Detail*). The volume of embankment material is estimated at 989,000 cubic yards. This initial

impoundment would have sufficient capacity to hold 3 million tons of tailings.

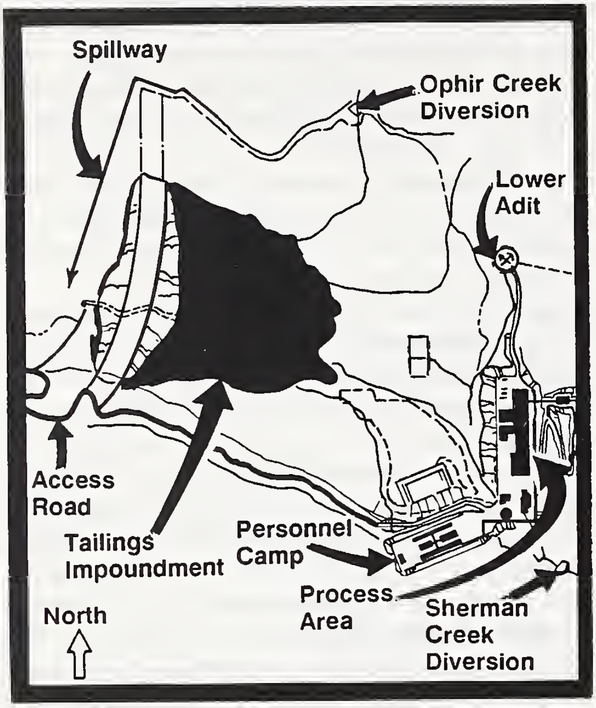


Figure 2-5, Sherman Creek Tailings Disposal Detail

Periodically over the life of the mine (years 2, 3, 4, 5, 8 and 12), subsequent raises would be added to the dam using a modified centerline construction technique. Ultimately the impoundment would reach a height of 270 feet (680 MSL) with a crest length of approximately 2,400 feet. The estimated final embankment volume is 2,200,000 cubic yards. This embankment location could impound approximately 30 million tons of tailings with 12 feet of freeboard. The height of freeboard would vary during the life of the project. The initial starter dam would have approximately 30 feet of freeboard. The amount of freeboard required reduces over time due to the increased impoundment area available for storage as subsequent lifts are added to the embankment. The impoundment has the capacity to store 256 acre-feet of non-mining related water during the initial development/ start-up phase. The tailings would be transported via pipeline from the mill a distance of 1,500 to 3,000 feet.

Foundation conditions at the site are considered good. Seepage control through the main embankment would be minimized by the inclusion of a low permeability till core (Knight & Piesold, Ltd., 1990). Other standard containment techniques, such as grout curtains or cutoff trenches would be used if field investigations indicate the need for such measures.

The embankment design involves an impermeable core constructed of fine grained materials borrowed from till deposits located upstream of the embankment. (*See Figure 2-6, Sherman Creek Tailings Embankment Design*). Coarse grained materials from talus, sand, and gravels located within the tailings basin would be used for the embankment shell zones and coarse filter materials. Waste rock from the mine would be used in raises following starter dam construction, as appropriate. Borrow areas would be confined to the tailings basin to minimize the disturbance area and increase the capacity of the structure.

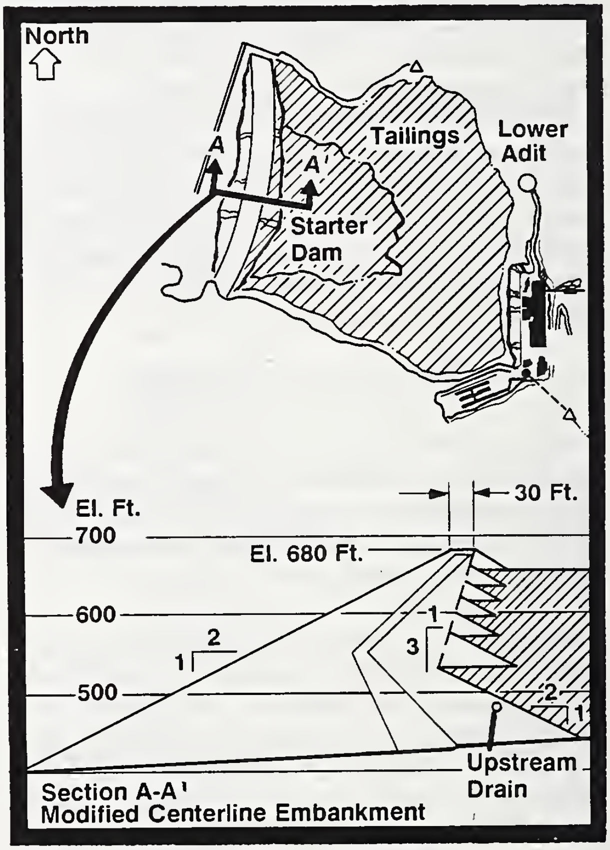


Figure 2-6, Sherman Creek Tailings Embankment Design

The design would control seepage through and beneath the structure. However, a seepage

collection structure would be necessary to return seepage from below the tailings dam back to the tailings pond.

Initially, Ophir and Sherman Creek channels would be diverted around the impoundment area. Diversion of Sherman Creek would occur at a small dam structure upstream of the mill site, which would also serve as the water supply intake. The Sherman Creek diversion would be an enclosed pipe. This diversion would be approximately 1 mile in length.

Ophir Creek would be diverted into a low velocity channel around the north side of the tailings pond and discharged into Sherman Creek. This diversion would be approximately 2,950 feet in length. Undiverted runoff from the tailings impoundment area (net precipitation) would enter the tailings pond and be routed via a valved decant system to a surface pipeline and discharged to Lynn Canal as part of the effluent discharge (Knight & Piesold, Ltd., 1990). Storm water discharges from the main facilities area would be routed to the sediment ponds located within the confines of the final impoundment. These ponds would serve as runoff retention and treatment. Runoff would be routed into the tailings pond for discharge via the valved decant system. The sediment ponds would cease to function when the tailings pond reaches its final elevation. Site runoff would be directed into the tailings pond which would provide adequate area for runoff treatment. Storm water volume calculations are found in Kensington Venture (1989).

Closure of the tailings impoundment would involve removal of the Sherman Creek and Ophir Creek diversions. Flow from Sherman Creek would be routed through an engineered channel across the upper portion of the impoundment and then into the permanent Ophir Creek diversion channel along the north edge of the impoundment. The combined flow of Sherman and Ophir creeks would then be discharged, via a permanent reinforced concrete channel, into Sherman Creek below the tailings embankment. (*See DEIS Appendix A*). The tailings pond decant system is designed to be permanently plugged at the upstream end of the pipeline to Lynn Canal. Surface flows across the tailings would be contained in a self-maintaining, engineered channel. All areas would be revegetated as required by the Forest Service. Depending on the level of design effort and anticipated effects of permanent channel construction, additional analysis under NEPA might be required at mine closure.

Other operational aspects of a Sherman Creek tailings impoundment would consist of an access road, slurry line and return water line.

Total surface disturbance associated with this disposal site would be 225 acres. The total drainage area above the impoundment is about 3.8 square miles (2,432 acres).

Sweeny Creek. Two tailings impoundment locations in the Sweeny Creek drainage were studied (SRK, 1987). The upper Sweeny Creek site was not considered feasible because of major embankment requirements and engineering constraints. The lower Sweeny Creek (or Sweeny Creek) site was considered feasible and is described below.

This site is located approximately 2.5 miles south of the mill site. Site conditions include steep side slopes, 30 percent and greater, adjacent to the existing creek. (*See Figure 2-7, Sweeny Creek Tailings Disposal Design*). The creek discharges to Lynn Canal south of Sherman Creek.

Materials required for construction of the dam are not available within the impoundment site due to the steep topography (Dames & Moore, 1989c). Rock quarries and borrow areas outside the impoundment area would be required to supplement the limited amount of waste rock to assure adequate material for construction. The initial starter dam would be approximately 310 feet high with a crest length of approximately 1,050 feet and is estimated to require 2.8 million cubic yards of construction material. This initial impoundment would have sufficient capacity to contain approximately 9 million tons of tailings.

Subsequent raises would be periodically added as required using a modified centerline construction technique. The subsequent raises would be constructed using quarry material and waste rock as available. Ultimately the dam would reach an approximate height of 370 feet

with a crest length of 1,400 feet. The final dam would require a total of approximately 3.1 million cubic yards to construct. The final impoundment would have capacity to hold 30 million tons of tailings.

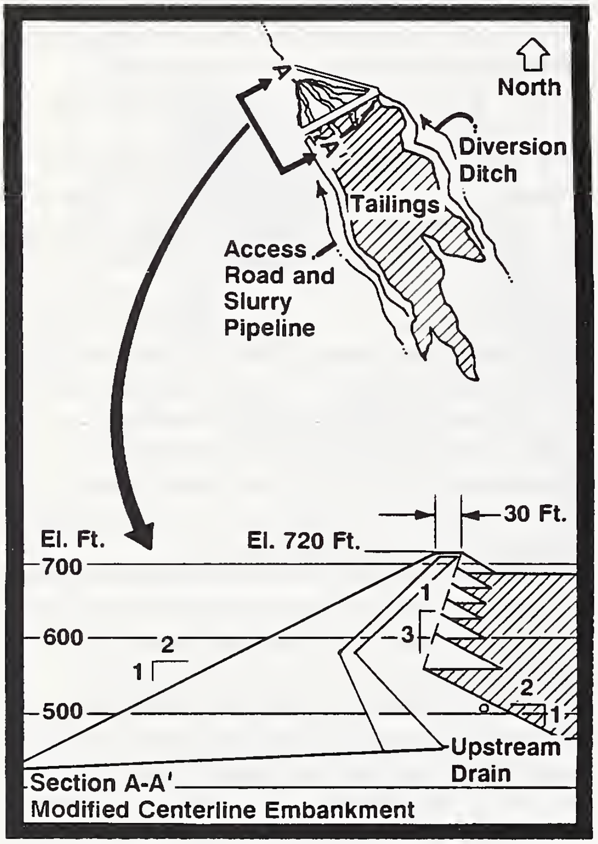


Figure 2-7, Sweeny Creek Tailings Disposal Design

The design would incorporate a fine grained low permeable core and a coarse gravel shell. A cut-off trench would be required in the foundation. In addition, seepage control measures such as grouting may be required.

Sweeny Creek would be diverted around the impoundment area via a pipeline (approximately 5,450 feet) to a 1,300 feet long permanent riprapped channel which would return the flow to the original channel below the impoundment. Undiverted runoff from about 145 acres above the impoundment area (net precipitation) would be routed through a valved decant system to a pipeline and discharged to Lynn Canal.

Upon closure of the tailings impoundment, the pipeline would be removed and all surface water from the drainage basin would be routed through a lined and riprapped channel across the impoundment and discharged, via a riprapped channel, back into the existing Sweeny Creek channel below the impoundment. Depending on the level of design effort and anticipated effects of permanent channel construction, additional analysis under NEPA might be required at mine closure.

Other operational aspects of a Sweeny Creek tailings impoundment would require an access road, slurry line, return water line, power supply with associated pump stations, and spill containment facilities.

The Sweeny Creek site is in close proximity to the proposed mill facilities and is attractive in terms of total potential storage capacity.

Total surface disturbance associated with this disposal site would be 135 acres. Total drainage area above the impoundment is 3.5 square miles (2,240 acres).

Dewatered Tailings Disposal

This method of tailings disposal would involve dewatering thickened flotation and concentrate tailings using filter presses and thermal drying until a moisture content not exceeding 14 percent is attained. Once dried, the tailings would be hauled to the disposal site for placement or, during inclement weather, placed in temporary covered storage until final placement is possible.

Two potential dewatered tailings disposal sites have been identified. Site A would be located on the slope north of Sherman Creek. Average ground slope within the foot print of the site is 15 percent. Total disturbed area for this site option would be approximately 170 acres. Maximum height of the tailings pile at Site A would be 340 feet. Site B would be located on the moderate slopes adjacent to Lynn Canal, between Sherman Creek and Sweeny Creek. Average ground slope within the footprint of Site B is approximately 10 percent. The disturbed area associated with Site B would be approximately 165 acres. The maximum height of the tailings pile at this site would be 280 feet. Location of the sites are shown on *Figure 2-8, Dewatered Tailings Disposal Site Options*.

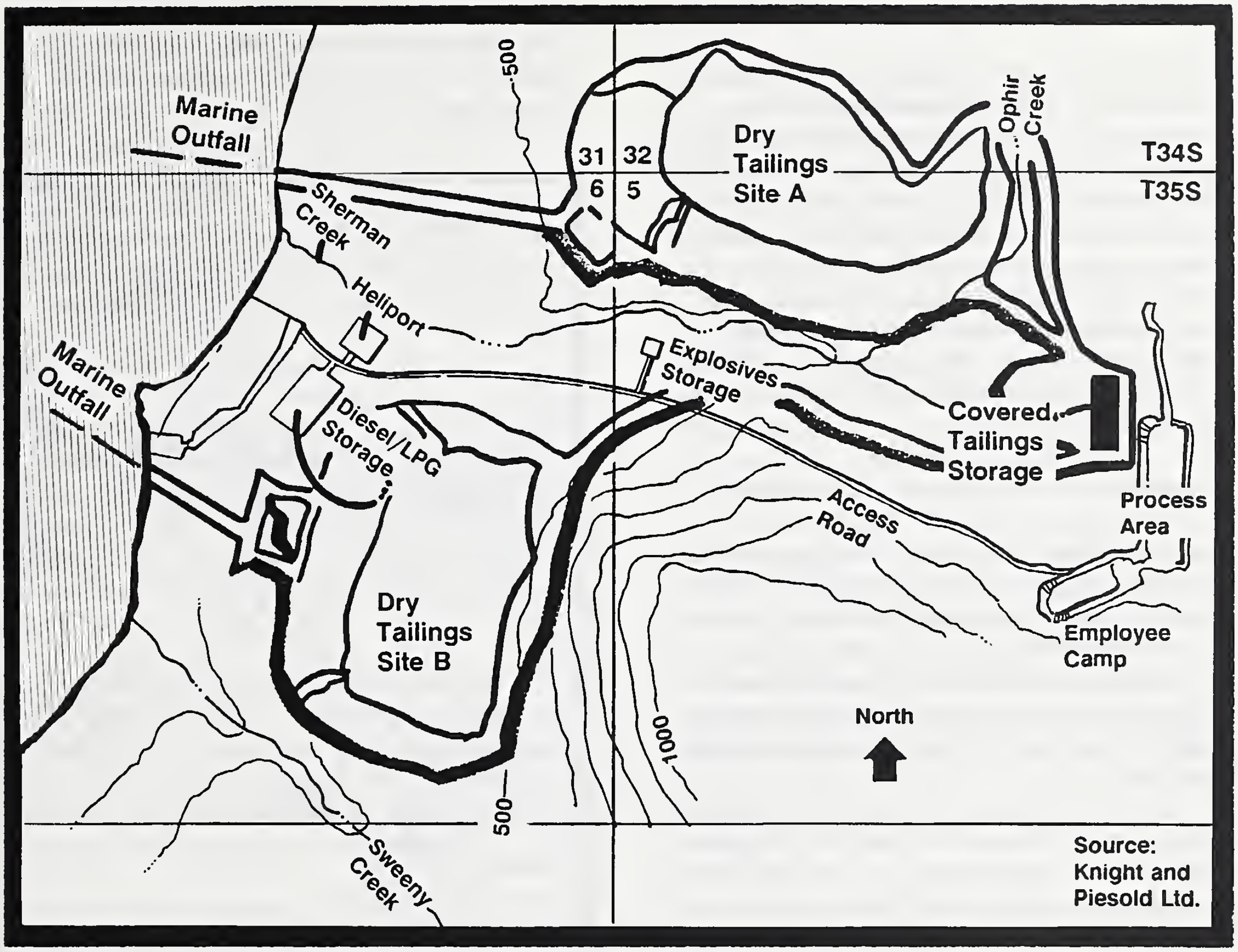


Figure 2-8, Dewatered Tailings Disposal Site Options

Construction of the structure and placement of the dewatered tailings would be the same for either Site A or B. Initially, a berm would be constructed at the toe of the structure using waste rock and/or borrow material. A compacted till liner and overlying drainage blanket would be constructed covering the basal area of the pile. Dewatered tailings would be placed and compacted in shallow lifts, with haulage roads constructed of waste rock placed on approximately 75 to 100 foot intervals. The schedule for placement of the dewatered tailings would be weather controlled due to moisture sensitivity of the tailings. Maximum tailings stability is achieved at about 14 percent moisture content. Moisture content above this level reduces tailings density and reduces overall pile stability. Placement of dewatered tailings on days when precipitation exceeds 0.25 inches would affect trafficability and stability of the structure.

During periods when rainfall exceeds 0.25 inches, tailings would have to be temporarily stored in a 50,000 square foot, 50-foot high building to maintain the required moisture content of 14 percent or less (Knight and Piesold, Ltd., 1991). Data indicates that this rainfall amount is exceeded 52 days each year and there are 48 days when snowfall exceeds 1 inch.

Waste rock would be used for construction of the initial berm and subsequent raises. Material for the drainage/foundation layer would be borrowed from within or near the disposal area. Rock armoring of the pile face would be needed for road access and erosion control. It is

anticipated that waste rock generated by the mining operation would be adequate for meeting this need.

Runoff from the surface of the pile would be controlled by a drainage collection system routing flows to a holding pond of about 4 acres located at the toe of the structure. A system of drainage control ditches located around the perimeter of the structure would divert surface runoff away from the side slopes of the pile. Excess water from the pile, accumulated as a result of net precipitation buildup, would be discharged from the holding pond via a marine outfall in accordance with an EPA administered NPDES Permit.

Dewatered tailings disposal areas A and B would be located in upland areas away from stream channels. Diversion channels would be constructed upgradient of the structure. These channels would route sheet flow runoff from adjacent undisturbed areas around the pile. The drainage control channels would either discharge into existing natural drainage ways or be directed through a series of flow dispersing structures.

Closure of the pile would require removal of all surface water control structures. The pile would be revegetated according to a Forest Service approved plan.

Dewatered tailings surface disposal addresses the issues of geotechnical stability of a tailings dam and the rerouting of natural water courses.

MARINE DISCHARGE

The project would require a marine discharge line for disposal of a combined stream containing mill effluent mine water discharge, treated sewage and storm water bypass. The discharge line would originate in the tailings pond under wet tailings disposal alternatives and in the runoff treatment and settling pond under dewatered tailings disposal methods.

Outfall Line Location

The Kensington Venture proposes an outfall off Comet Beach along the alignment shown on *Figure 2-9, Outfall Options*. The DEIS analyzed only this outfall. Public input on the DEIS brought forward an alternate location south of Point Sherman. The alignment of this option is also shown on *Figure 2-9, Outfall Options*. This option reduces the potential for conflicts between the fishing fleet anchorage and the outfall pipe.

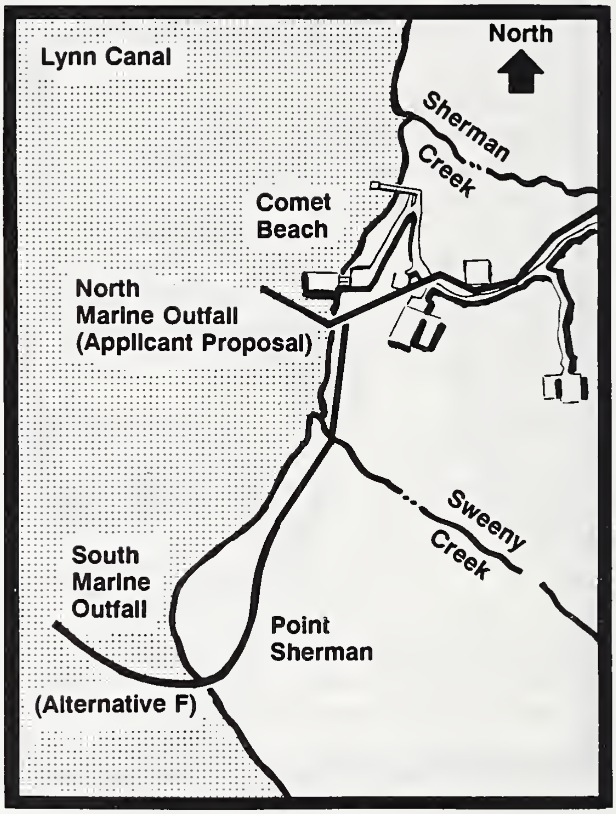


Figure 2-9, Outfall Options

Mixing Zone

The FEIS analyzes effluent discharge into a mixing zone in Lynn Canal. The FEIS analysis was based on a mixing zone estimated from effluent characteristics calculated in the FEIS as well as other reasonable assumptions of discharge quantity, depth and diffuser design.

HOUSING AND TRANSPORTATION

Onsite Employee Housing Camp

The Kensington Venture proposes to construct and operate a permanent 250 person remote (onsite) employee housing camp. During construction, a maximum of approximately 500 workers would be housed on site. The tentative operational work schedule would require that

approximately 170 people be onsite at any one time. The camp would be sized for 250 persons and provide spare rooms for visitors and occasional staffing requirements at the site.

The camp would include a kitchen, dining room, recreational facilities, and sleeping quarters. Although the final rotational schedule for employees has not been determined, it would be on a basis of 7 days on and 7 days off, 14 days on and 14 days off, or some similar type arrangements involving a common denominator.

Daily Ferry Commute

A daily commute to the site from Juneau would involve transporting a minimum of 150 people from Juneau to the mine site and back again each day of the year. This option would require busing and/or car-pooling, adequate parking at the docking facility and a ferry shuttle system to the site.

A 250 person housing camp would not be required with this option; however, onsite facilities would be constructed and maintained to provide housing for construction workers, and emergency housing should weather preclude daily transport of employees.

Two potential destination sites were initially evaluated for the daily ferry commute option. The Comet Beach option was eliminated from detailed consideration for reasons discussed in a subsequent section (*See Project Components Not Studied in Detail, Chapter 2*). The Slate Creek Cove (The McDowell Group, 1990a) option is discussed in the following section.

This option addresses socioeconomic concerns associated with an onsite camp.

Water Transport

Ferry transport of employees and barge transport of supplies was evaluated for the Kensington Project. Ferry transport of personnel is presently being used at the Greens Creek Mine on Admiralty Island from a facility north of Auke Bay to Youngs Bay.

Comet Beach. A Comet Beach marine terminal location for unloading supplies and materials would have the advantage of requiring no new road construction and limiting additional road transportation requirements from Slate Creek Cove to the mine site.

Establishment of a breakwater at Comet Beach is not considered feasible. (*See Project Component Options Not Studied in Detail, Chapter 2*). Activities at this site would be restricted to off-loading of supplies, fuel, and equipment. Supplies would be stockpiled or stored onsite in sufficient quantities to avoid off-loading during bad weather conditions and maintain the operations during extended stormy periods. Emergency shipment of supplies or parts could be by air transport, but this technique would not be the normal method of transporting supplies and would only occur occasionally during the life of the operation.

The Kensington Venture proposes to construct a fuel transfer station and barge landing area south of the mouth of Sherman Creek at Comet Beach as part of the marine terminal. The facility would accommodate both fuel and supply barges. (*See Figure 2-10, Comet Beach Marine Terminal Facility*). The general shipping route for barge transport to Comet Beach is indicated on *Figure 2-11, Ferry and Barge Routes*.

The marine terminal would consist of a ramp of pre-cast concrete planks anchored to bedrock. The slope of the ramp is approximately 10 percent, allowing unloading by forklift. Two mooring dolphins would stabilize barges during off-loading, and the barges would carry long ramps for unloading. The design of the landing facility would not inhibit fish migration in Lynn Canal. An adjacent staging area is equipped with special hazardous materials and fuel handling supplies.

Access from the marine terminal to the mine and surface facilities would follow the alignment of the existing road. The road would also service the explosives storage area which would be located in a remote site south of the helicopter facility.

Shipment of supplies would be scheduled, when possible, to avoid bad weather and minimize disturbance to the commercial fishing fleet around Point Sherman in Lynn Canal. Onsite storage capabilities would be sized to maintain

sufficient supplies if supply transportation is hindered during an extended stormy period.

strong northerly winds which constrain the use of a similar facility in Comet Beach during the

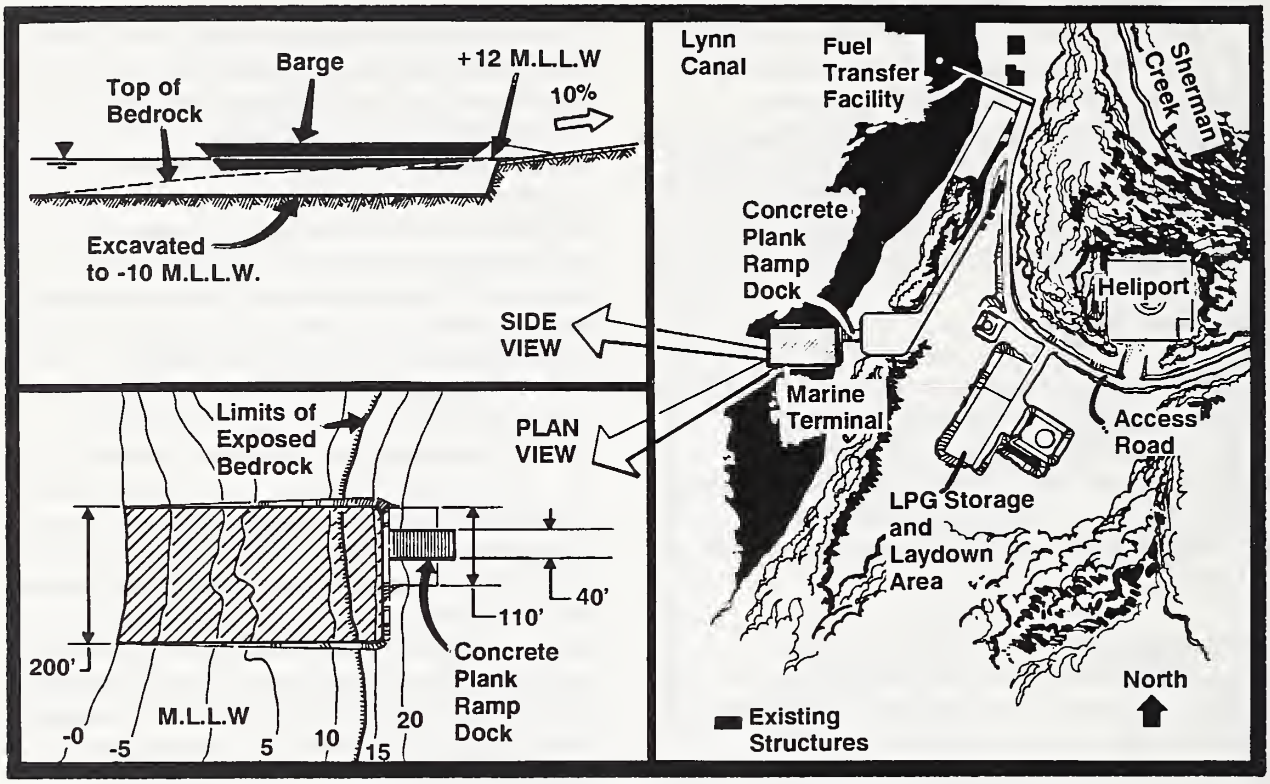


Figure 2-10, Comet Beach Marine Terminal Facility

This terminal could also be used within the context of joint facilities if a mining operation is proposed at the Jualin site. Supplies could be transported through a tunnel to the Johnson Creek drainage and the Jualin property. This option would be studied in detail in a future NEPA analysis, at such time as a firm development proposal is submitted by the Jualin Operator.

Slate Creek Cove. Besides a marine terminal in Lynn Canal at Comet Beach, Slate Creek Cove is another destination option for marine transportation of employees or supplies. Daily reliability of across water travel during stormy periods would be higher with this option, as compared to the Comet Beach option.

Slate Creek Cove is located along the north side of Berners Bay at the mouth of Slate Creek. A Slate Creek Cove facility would be situated on the east side of the peninsula terminating at Point St. Mary and be more protected from winter season. This alternative would provide for a combination barge/ferry terminal constructed at Slate Creek Cove. (*See Figure 2-11, Ferry and Barge Routes*). The facility could consist of an access fill and transfer bridge supported on a float. (*See Figure 2-12, Slate Creek Cove Facility*).

A ferry would transport employees from Auke Bay to Slate Creek Cove. (*See Figure 2-11, Ferry and Barge Routes*). The ferry trip would take approximately 2 hours each way. In combination with a marine ferry system, an 8.5 mile road would be constructed from Slate Creek Cove to the mine site in Sherman Creek. Employees would be transferred from the marine ferry onto a shuttle vehicle, probably a bus, for the trip from Slate Creek Cove to the mine.

The Slate Creek Cove site also offers a potential for future joint use if the Jualin Mine is developed.

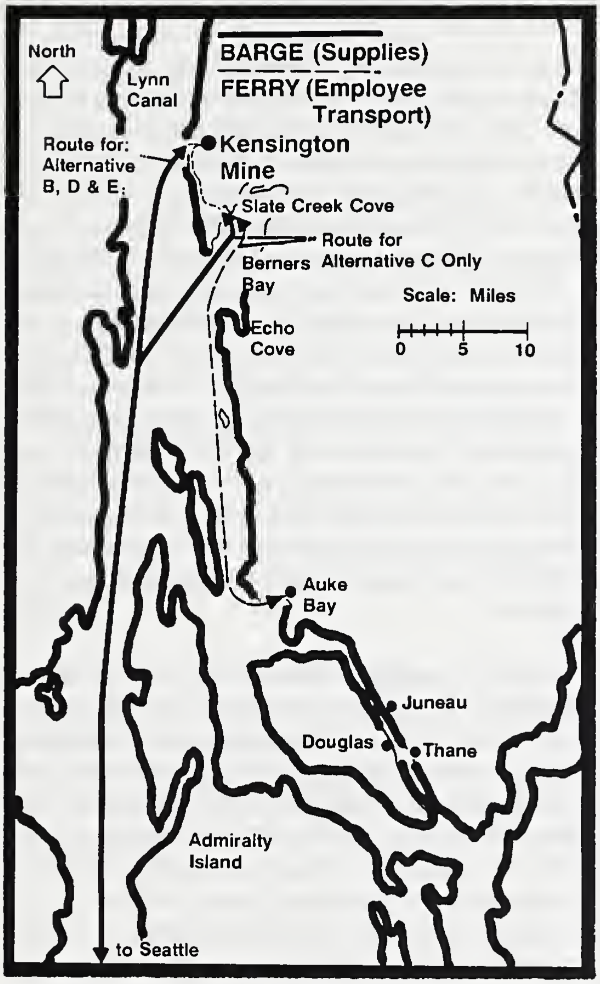


Figure 2-11, Ferry and Barge Routes

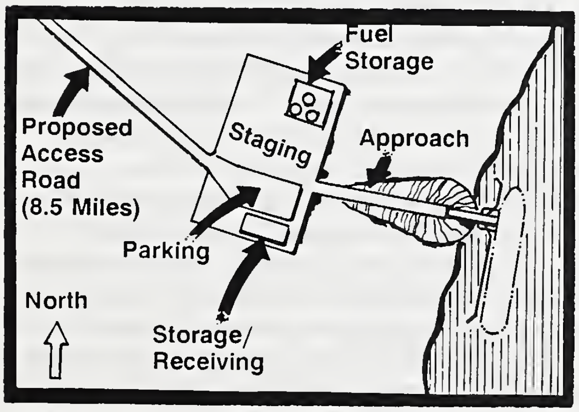


Figure 2-12, Slate Creek Cove Facility

Helicopter Employee Transport

The Kensington Venture has proposed transporting miners to the site via helicopter. Such air service would be between Juneau and a heliport constructed at the project site. Flight frequency would average two to four flights per day, five days per week during operations. Construction would require more frequent flights.

At present, the Kensington Venture has no plans to provide air service between the mine site and Haines or Skagway. Employees would be air shuttled to and from Juneau on a rotating schedule. Employee housing is planned onsite, and workers would work a rotating shift such as 7 days on, 7 days off; 14 days on, 14 days off; or some other similar rotation.

Although often considered to be high cost and low transport capability, the use of the helicopter emerged as the Applicant's proposed option for employee transport. The costs associated with the construction and operation of an airstrip for fixed-wing aircraft would be substantially higher than those associated with heliport operation. Large helicopters that carry 15 to 20 passengers are commercially available (S-58T or similar aircraft) and would provide more reliable service than a Twin Otter fixed-wing aircraft (DMC, 1990b).

These helicopters can also handle a sling-load capacity of 5,000 pounds, providing certain utility for priority freight transport. Their improved reliability is primarily due to their ability to operate in lower minimum clearances. The FEIS studies two variations on this transportation mode. The first option, studied in the DEIS has the airships departing the Juneau Airport. The second option, added to the FEIS as a result of public input, uses a helicopter landing zone near Yankee/Bridget Cove rather than the Juneau Airport.

Juneau Airport. Helicopters would leave the Juneau airport and proceed up Montana Creek, then toward the mouth of Cowee Creek, across Berners Bay and then proceed along the coastline of Lynn Canal to the Project site. The flight path would be located over land as much as possible for safety considerations. Variation from this flight path could occur during extreme

weather conditions. (*See Figure 2-13, Helicopter Flight Path*).

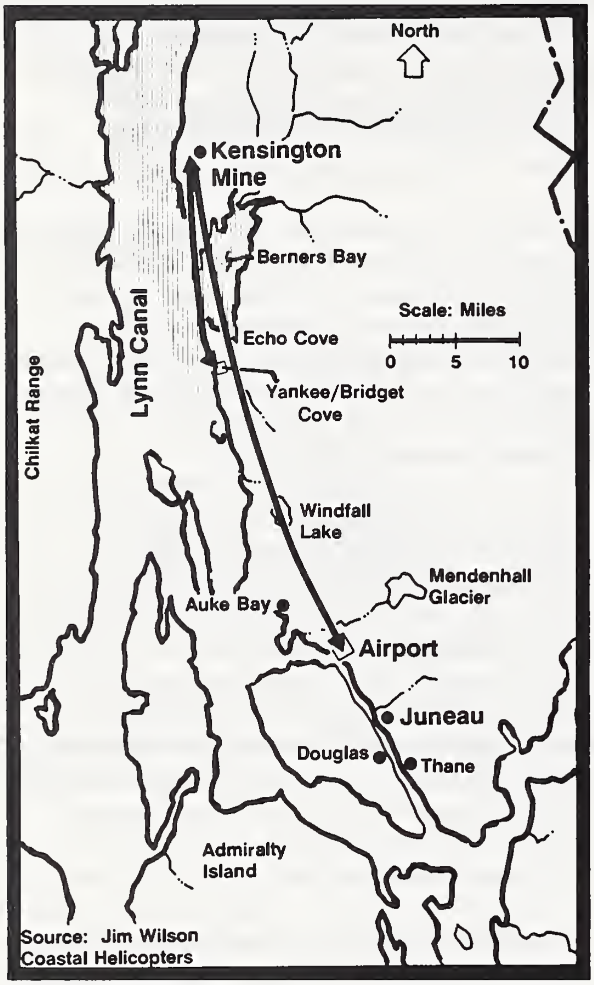


Figure 2-13, Helicopter Flight Path

The helicopters would climb quickly to a minimum altitude of 300 feet. They would maintain this minimum altitude over all residential areas. Weather permitting, the helicopters would travel at an elevation of 2,000 feet, well above the 300 foot minimum.

Yankee/Bridget Cove. Yankee and Bridget coves are located about 3 miles apart past the end of the pavement on Glacier Highway. Along this stretch of highway are a number of potential locations for a helipad. The analysis uses no specific location. Instead, it is assumed that a suitable site can be found for the helipad. All sites have similar attributes insofar as they would alleviate any parking or traffic concerns at the Juneau Airport and would eliminate project related helicopter noise impacts to homeowners and recreationists between the airport and the selected site.

The analysis rests on the assumption that workers would travel in individual vehicles to the heliport. The issue of traffic increases on Glacier Highway has been raised. Some members of the public expressed concern about employee traffic in Auke Bay and suggested that the northern heliport should be combined with busing. It has been pointed out that shift change at the Greens Creek ferry imposes significant traffic on Glacier Highway through Auke Bay. The Greens Creek situation is different in that the ferry transports up to 150 people at a time, whereas the helicopter will transport only 15 to 20. Therefore, the EIS will analyze individual transport as a worst case for this option. If selected, and if traffic becomes a problem, busing could always be added at a later date.

Landing area requirements for the heliport near Comet Beach would involve a 500 by 500 foot cleared area with a 100 square foot concrete-surfaced landing pad and Federal Aviation Administration approved communications and safety equipment. Two additional smaller helipads (one at the upper portal and one near the facilities area) would be used only for emergency purposes and intermittent operational activities.

WATER SUPPLY

The Kensington Venture proposes to use a combination of surface and ground water for domestic and process use. An impoundment in Sherman Creek above the mine would allow for a diversion of surface water for use in ore processing activities and other uses. Withdrawal rates would vary between 0 and 350 gallons per minute (gpm) for startup and from 0 to 200 gpm for operations. No withdrawal would be allowed during critical low flow periods. Drainage from the underground mine (ground water) would also be used in the process. If required, a ground water field would supplement surface water, water from the underground workings or other alternative sources. The Kensington Venture also plans to recycle water from the tailings pond during the life of the operations.

POWER SUPPLY

The Kensington Venture proposes to generate electric power onsite because the area is not serviced by any local utility. Electric power would be provided by turbine generators during operations. The Applicant proposes to run the turbine generators on liquid petroleum gas (LPG). LPG provides the opportunity for reduced air emissions, as well as certain advantages in transport safety. With diesel fuel, sulfur dioxide (SO_2) emissions are the primary concern. In the case of LPG, nitrogen dioxide (NO_2) is the primary emission of concern. A comparison of similar sized generating facilities using diesel versus LPG fuel showed SO_2 emissions for the LPG generators to be about 1 percent of those for a comparable system utilizing diesel. Similarly, NO_2 emissions for the LPG option would be expected to be about 15 percent of those for its diesel counterpart (TRC, 1991).

Diesel fuel will be used as the primary power supply during project construction. The FEIS analyzes diesel use at a level equal to that needed during project operation. Construction power needs are not yet defined and using this level for analysis in the FEIS will cover all possible construction period emission rates.

FUEL USE AND STORAGE

Three types of fuel would be stored on site: LPG, diesel, and aviation. The proposed fuel transfer and storage facilities would be located near the marine terminal in Lynn Canal. *(See Figure 2-10, Comet Beach Marine Terminal Facility)*. Fuel would be off-loaded at the Kensington site at a fuel transfer station located south of the mouth of Sherman Creek in Lynn Canal. *(See Figure 2-14, Fuel Transfer Facility)*. LPG and diesel fuel would be transferred from barges at this site and pumped or piped to the onshore storage facilities.

Fuel transfer would be accomplished with the use of a shore-based platform raft which would travel to the fuel barge. The barge would be moored to four buoys to maintain its position. Fuel transfer lines would be attached from the barge to the platform to the shore. Spill containment equipment would be maintained on the platform, including 2,500 feet of sorbent boom.

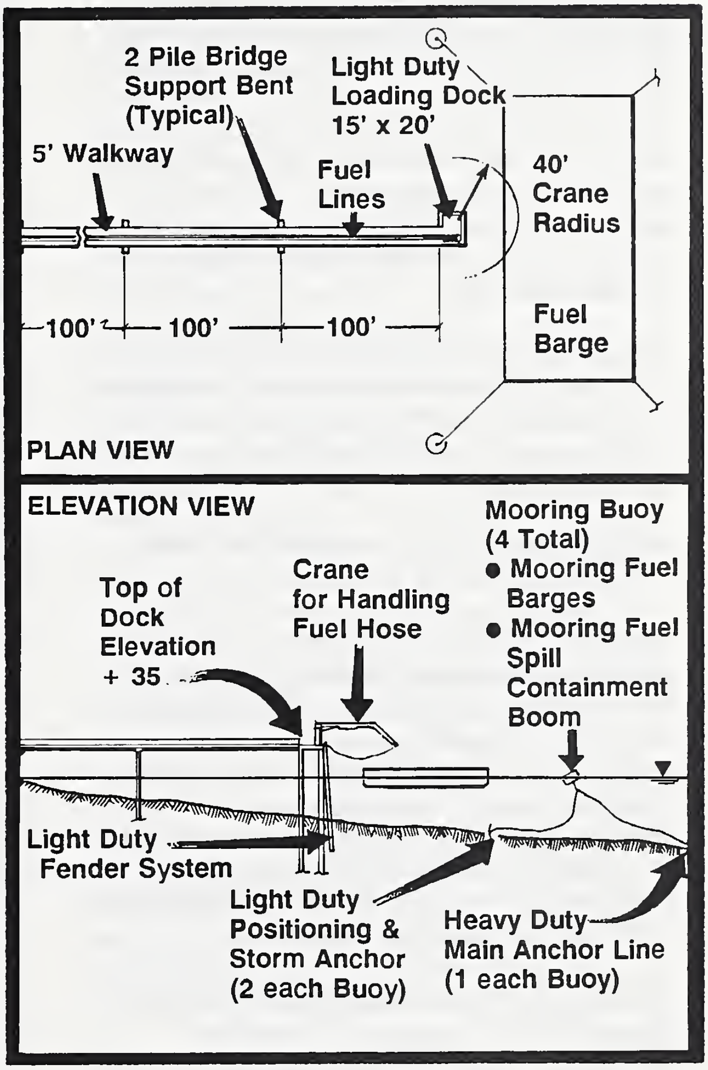


Figure 2-14, Fuel Transfer Facility

The Kensington Venture proposes to store fuel in above ground tanks enclosed with berms. The berms and containment areas would be sized and lined with low permeability synthetic or natural (clay) liners to contain the contents of the tanks in the event of a spill or tank rupture.

LPG fuel would be stored in a 76 foot diameter metal sphere capable of holding 300,000 gallons. LPG would be pumped or piped to a 20,000 gallon tank near the turbine generators located adjacent to the mill and service complex.

Diesel storage would be provided at two locations: one, holding 150,000 gallons, would be at the marine terminal area, another holding 20,000 gallons would be at the mill near the mine portal. A small storage facility, capable of storing 10,000 to 15,000 gallons of helicopter fuel and 5,000 gallons of diesel fuel, would be located at the heliport.

Diesel fuel would be used for both underground and surface mobile equipment. This fuel would be piped, pumped, or transported by a 2,500 gallon fuel tanker truck to a fueling station adjacent to the mill.

The only option considered in detail for location of fuel facilities would involve fuel transfer at the Slate Creek Cove terminal site. Fuel would then be transported over the 8.5 miles of road, either by truck or pipeline.

HAZARDOUS MATERIALS HANDLING AND STORAGE

Chemicals and reagents required for project operation would be purchased from vendors in the lower 48 states. *Table 2-2, Chemical and Reagent Use* lists primary chemicals and reagents required for milling and processing. The materials would be transported by rail or truck to Seattle, Washington where they would be consolidated for barge shipment to the project site in accordance with U.S. Department of Transportation shipping regulations.

Sodium cyanide use at the site is estimated to be up to 320 tons per year. It would be manufactured by DuPont in Memphis, Tennessee and shipped by rail car to Seattle, Washington. It would be loaded onto Alaska Marine Lines barges for shipment to the mine site. The Kensington Venture has a signed agreement with DuPont to supply sodium cyanide in specifically designed International Standards Organization (ISO) containers with self contained radio beacons. The capacity of the ISO containers is about 32,000 pounds. Two barge shipments of 10 ISO containers each would be required per year. The containers are loaded into the center of the barge with no stacking of the containers allowed. These containers are physically separated from any chemicals which could potentially react with the sodium cyanide.

The freight company would sort supplies into ISO size container lots in compliance with U.S. Coast Guard regulations specifying the compatibility of the various substances. Individual supplies would be in sealed containers inside the steel ISO containers. Most often, an ISO container would hold only one type of supply. Specific Coast Guard and manufacturers' practices dictate that containers with cyanide not be loaded at the edge of the barge.

Kensington Venture has proposed a Hazardous Material Handling Plan as part of the Plan of Operations. (*See DEIS Appendix A*).

WASTE DISPOSAL

The Forest Service controls solid waste disposal on National Forest System Lands. The following disposal methods proposed by the applicant meet current Forest Service waste disposal policies.

Onsite Incineration with Offsite Disposal

The Applicant has proposed the following methods for solid waste handling and disposal. Solid waste would be handled by placing twin bear-proof dumpsters at strategic locations surrounding the operation. Dumpsters would be placed at the marine terminal, the process complex, and the employee housing camp. One side of each dumpster unit would accept combustible solid waste which would be collected daily and taken to the fenced bear-proof incinerator installation at a site near the housing camp.

The incinerator would be a commercial unit designed to handle the anticipated load during both construction and operating phases. The incinerator would be installed and operated to meet all applicable government air emission standards.

The other side of each dumpster would collect non-combustible solid waste which, with any incinerator residue, would be removed from the site and disposed of at an approved solid waste facility in Juneau, or barged to other approved disposal sites outside Juneau, if necessary.

Waste oil would be collected separately and shipped to Juneau for ultimate disposal.

Hazardous Waste Disposal

A number of chemical reagents and hazardous materials would be used at the Kensington Project. Over the expected 12 years of life, the project would be a small quantity generator (generating less than 2200 pounds per month) of hazardous wastes and be regulated under the Resource Conservation and Recovery Act (RCRA). Hazardous wastes would be temporarily stored onsite, in accordance with an approved Hazardous Material Handling Plan, before being transported to a permitted hazardous waste treatment and disposal facility in accordance with all federal, State, and local requirements.

Sewage Disposal

The Applicant has proposed onsite package plant treatment for sewage disposal. Treated effluent from this plant would be disposed of by discharge into the tailings pond effluent line to Lynn Canal.

Any sewage disposal system would be subject to permit requirements of ADEC. The ADEC regulations are specifically designed to ensure that any new sewage disposal systems comply with all applicable water quality maintenance regulations. The sewage outfall would be directed into the marine outfall line below the tailings structure.

ROCK QUARRY

The Kensington Venture proposes to develop several rock quarries or borrow areas to serve as a rock source for both construction activities and long-term operational needs. These quarries would be located within the maximum confines of the proposed Sherman Creek tailings impoundment area. They would be used to supply rock material for the construction of the tailings dam as well as increase the overall volume capacity of the tailings impoundment. Only late in the project life would their function cease and tailings encroach into the quarries.

Construction of the initial starter dam for the Sweeny Creek tailings impoundment would require approximately 2.8 million cubic yards of material. This material would be provided from quarries located near the impoundment site. Sufficient waste rock from mining would not be available at early stages of construction, therefore, the majority of the 2.8 million cubic yards of required construction material would have to come from quarries.

The Kensington Venture also proposes to use underground development waste rock for miscellaneous construction. A balanced cut and fill design for all roads and other surface facilities would be engineered where possible. This would eliminate or minimize the need for an external rock supply. When plans do not provide sufficient rock material according to the construction schedule, the Kensington Venture would obtain rock from the quarry. A small portable rock crusher would be required to reduce the quarry rock to gravel size for road surfacing or for use in a concrete batch plant.

Depending on the action alternative selected for the Kensington Gold Project, it would be necessary to locate and size rock quarries to provide for rock material to be used in construction of the tailings embankment, roads, facilities, etc.. For example, a road from Slate Creek Cove to the Sherman Creek drainage would require a rock supply for its construction and a gravel source for its surfacing. Location and size options for rock quarries would be specific to the individual alternatives studied.

GENERATOR LOCATION

The applicant has proposed locating the generators near the process facilities in Sherman Creek basin. This location allows waste heat recovered from the turbines to be used in heating the camp. It requires constructing a pipeline from the LPG storage tank to the facilities area and a powerline from the generators to the facilities at Comet Beach.

An alternative is to locate the generators closer to the LPG storage tank. This would reduce the length of pipeline needed to transfer LPG from the tank to the turbines. It would require a line from the generators to the facilities. This line would be larger than the one proposed by the

Kensington Venture as power consumption at the facilities is greater than at the beach. Both generator locations are evaluated in action alternatives.

PROJECT COMPONENT OPTIONS NOT STUDIED IN DETAIL

During the planning and scoping process several options for project components were identified. Some of the options were eliminated from detailed study in this EIS based on technical, environmental, legal, and regulatory constraints. Following are summaries of those options along with reasons for eliminating them from detailed consideration.

MINING METHODS

Surface Mining

Surface mining would neither be economical nor environmentally preferable due to climatic and topographic conditions. To recover outlined reserves by surface methods would require a pit approximately 1 mile in width and 1.5 miles in length.

This pit would result in impacts to approximately 950 acres, plus disturbance for the associated waste dumps. The volume of waste produced by this size of operation is estimated to be over 500,000,000 cubic yards. The area disturbed by the pit and waste dumps plus the volume of waste removed makes a surface mine environmentally undesirable. Land use/reclamation objectives related to the LUD II designation are not met by this option.

Cut and Fill Mining

Access to the ore body by the cut and fill mining method would be the same as with long hole, open stoping. Cut and fill mining is used in ore deposits which are mined from the bottom up. It minimizes unrecoverable pillars and supports weak wall rock. Cut and fill mining minimizes dilution and can be selective. Typically stope widths of 30 to 40 feet are mined. Wider stopes require use of interim longitudinal pillars or modification of the method to a drift and fill technique.

In this method, ore is removed by overhand mining while working on the previously placed fill surface. (*See Figure 2-15, Cut and Fill Mining*). The work areas are large to accommodate filling activities in one area and mining activities in another. Filling requires double handling of the majority of the ore. As a result, additional equipment and personnel are required to prepare, transport, and place the fill. The estimated labor for underground activities and supervision and technical support is approximately 190 persons for the projected production rate.

Placement of fill involves dewatering of tailings, addition of cement, and drainage of contained water following placement. Cement would be required to strengthen the fill because miners and equipment must work on the fill surface to mine the next cut.

A cut and fill operation uses relatively safe techniques but requires mechanical roof support over the entire stope area. While more selective mining can be completed and bulk material handling equipment can be used, this method requires more engineering, planning, and production manpower to implement.

At the Kensington Project the principal advantages of cut and fill mining revolve around reduction of surface impacts by minimizing surface tailings disposal. Practically, about 50 percent of the tailings (by weight) could be returned underground (Redpath, 1991). This would leave 10,000,000 tons of tailings to be disposed on the surface. The tailings fraction disposed on the surface would be fines, and would be less dense than the total tailings. Thus, surface disposal would be sized to accommodate approximately 60 percent of the total tailings (by volume)(SRK, 1991).

For the Sherman Creek impoundment, this would result in a reduction of dam height from 270 feet to 230 feet. At Sweeny Creek the height reduction would be from 370 feet to 330 feet. For the dry tailings options, pile height could be reduced by about 30 percent if the footprint remained the same. Pile A would be reduced from about 280 feet high to about 195 feet high. Dry tailings storage at site B would go from 350 feet to about 245 feet high. Conversely, if pile height were maintained

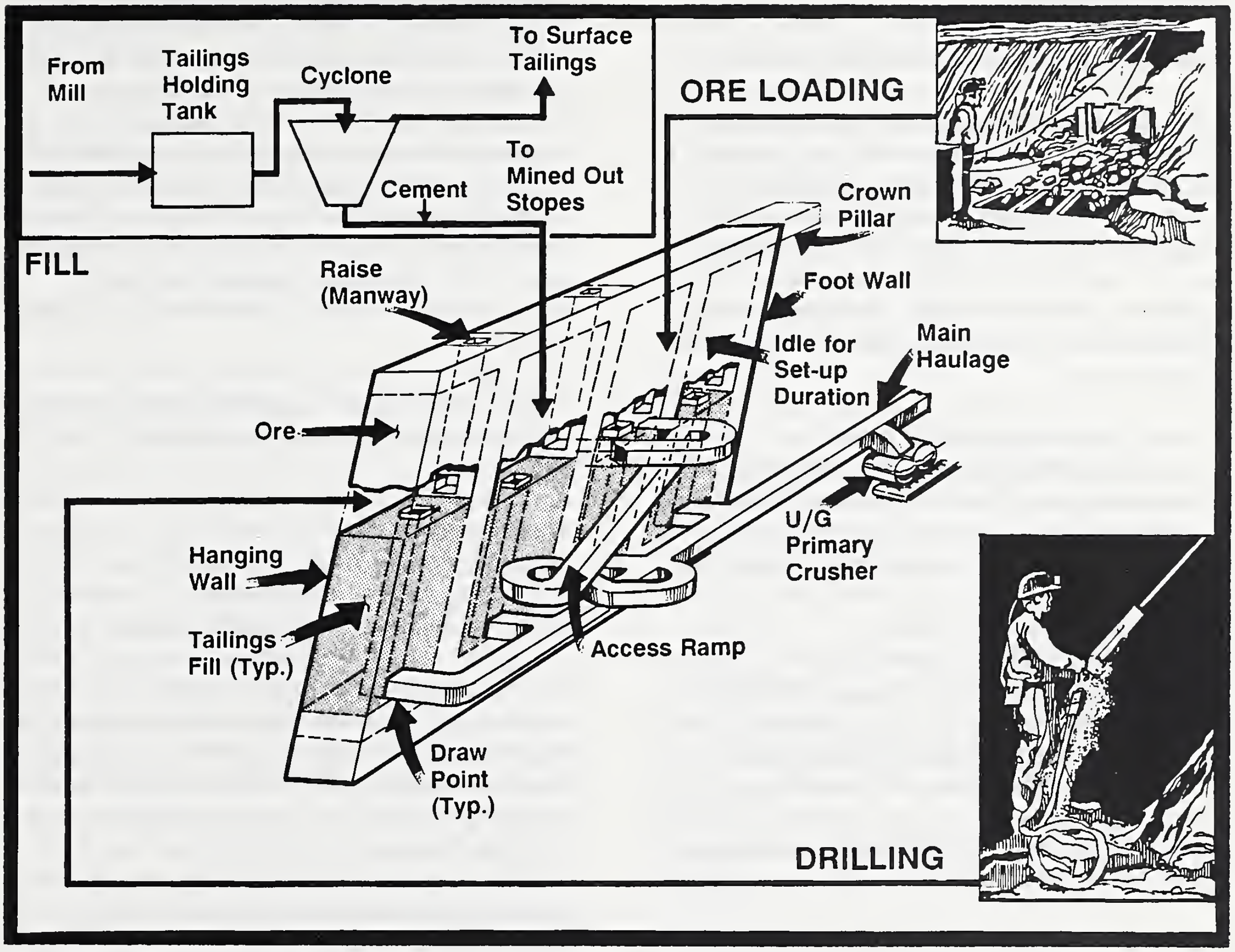


Figure 2-15, Cut and Fill Mining

constant, pile footprint could be reduced by about 30 to 35 percent.

Unfortunately, the disposal of half the tailings underground does little to reduce surface impacts. Visual impacts would be similar, short term wildlife habitat losses would change very little and there would be no change in risks of surface water contamination. No surface impact would be eliminated.

The Kensington Venture has estimated that capital costs of backfilling could exceed $5,000,000 combined with operating costs of $10/ton (or $100,000,000) (SRK, 1991). This option does not warrant further study in view of the relatively small reduction in environmental impacts. Economic considerations also do not support this option.

ORE PROCESSING

Surface Crushing Facilities

The surface crushing operation would require a similar crushing system as described for underground. Ore would be hauled to a surface crusher using haul trucks. Increased surface disturbance would be needed for the crusher area and related service roads.

This option would replace relatively energy efficient conveyors with less efficient trucks for haulage. The higher energy use for haulage would be compounded by energy needs of an enlarged mine ventilation system made necessary by the diesel truck engines. More employees would be needed and operating costs would be higher under this option. This

option does not favorably address any scoping issues, increases energy usage, and increases surface disturbance.

Underground Flotation and Cyanidation

Placement of flotation and cyanidation facilities underground could be feasible if the grinding operations were also located underground. Underground flotation and cyanidation would require additional excavation for the facilities.

Key factors important in the consideration of underground operation of these facilities include the following:

- Additional ventilation and power requirements (fail safe safety measures)
- Increased transportation of reagents and risk for spills
- Need for specialized vehicles to transport reagents
- Enclosure of solution tanks
- Additional safety concerns
- Required 8 hour shift and associated higher labor costs
- Minimized room for potential expansion
- Additional traffic in the primary adit

These factors result in significantly higher capital and operating costs for the project.

Employee safety risks increase in an underground milling operation. Space is at a premium in this type of installation increasing hazardous situations. Cramped working condition make chemical reagent handling more prone to error. Egress from the milling chamber is restricted due to lack of space. If problems in the process control circuit result in liberation of noxious fumes, employee escape is hindered. Relative to a surface installation, this increases the possibility of employee injury or death as a result of exposure to HCN gas.

Because of these factors and the fact that underground placement of these facilities would result in only minor reductions in surface disturbance, this option was not given detailed consideration.

Heap Leaching

Heap leaching is a gold processing method which involves the placement of crushed ore on sealed impermeable pads. Pads are lined with asphalt or synthetic liners. A dilute sodium cyanide solution is applied by drip or spray irrigation techniques. The solution is allowed to percolate through the stockpiled ore dissolving the gold values. The pregnant solution flows from the leach pad into a pregnant solution pond. The gold-bearing solution is then pumped into a recovery plant where the gold is extracted.

Certain characteristics must be present for heap leaching to be a viable and economic alternative.

- Oxide ore
- Level topography for pad construction
- Close proximity to the mine
- Isolation from surface and groundwater

The Kensington Project site and ores do not meet any of the criteria for successful heap leach operations. The heap leach process also does not address any of the key project issues including minimization of land disturbance and potential impacts on the local watershed and related water quality and fisheries resources. Visual quality objectives also would not be achieved under this option.

Vat Leaching

Vat leaching is an ore treatment process designed for rapid recovery of metal values from relatively high grade deposits. The ore is transported to a facility where the ore is crushed and agglomerated (mixing the ore with lime or cement and sodium cyanide) into pellets to improve permeability. The pelletized ore is transferred to a sealed concrete leaching vat. The pelletized ore is then subjected to cyanide leach for 24 to 100 hours. The vats are drained and washed with barren solution followed by fresh water rinse. Wash water is added to the mill solution, while the pregnant solution is cycled to a gold recovery circuit. Finally, leached ore is removed from the vat and transported to a spent ore disposal site.

As with heap leaching, certain characteristics must be present to make vat leaching a feasible milling alternative. The Kensington ore must be finely ground to liberate gold. Inherent limitations to dry grinding make this alternative technically infeasible. The ore is sulfide and telluride rather than oxide. Vat leaching (like heap leaching) is feasible only with oxide ores. The vat leaching process does not meet key issues and concerns identified in the scoping process.

Offsite Ore Processing

Complete offsite processing of the ore was considered as a possible project option. The advantage to offsite processing is that all the surface disturbance and potential environmental effects of onsite processing and tailings disposal could be eliminated from National Forest lands in the immediate vicinity of the mine, provided an alternate site is available and permitted. This includes not only the direct impacts of the milling operation and tailings disposal, but also the transportation of mill workers, chemical reagents, and fuel for power. These impacts could be expected to be offset by transportation of the ore to another location and disturbance at that location.

This option would require transporting 4,000 tons per day down the 2.5 mile road from the portal to Comet Beach or an alternate marine terminal site. Using 33 ton trucks, 121 round trips per day would be needed from the mine to the beach. A conveyor also could be used to transport ore from the mine to the beach to eliminate truck traffic and additional personnel to haul the ore.

A large stockpile and storage facility would be required at Comet Beach to store ore for eventual transport offsite due to restrictive weather conditions in Lynn Canal. Covered storage would be preferable to prevent wind blown dust and additional moisture to the ore. A covered facility would be highly visible from Lynn Canal. A facility sufficient to store at least 30 days (120,000 tons) of mine production would be needed to assure minimum performance reliability. Nominal dimensions of a building large enough to store this amount of ore are approximately 300 X 350 X 80 feet high. An all weather dock and a breakwater would be required to handle ships for ore shipment offsite.

Stored ore would be conveyed into a ship or barge for transport offsite. If barges were used, approximately one or more barges would be loaded each day depending on barge capacity. This would add two or more barge trips per day to existing Lynn Canal traffic. Barges would be used if a processing facility were located close to the site. Conversely, large transport ships (about 20,000 dead weight tons) would be used for distant facilities. This would add 1 to 2 ship passages weekly to existing Lynn Canal traffic.

There are no known operating offsite processing facilities that could accommodate ore. Construction of a new offsite mill and tailings facility would be required. The most reasonable place for such a facility would be within the road system around Juneau to take advantage of the existing infrastructure (DMC, 1990a).

There do not appear to be any significant environmental advantages to offsite processing. Similar disturbed areas would result from construction of mill facilities and tailings disposal at another location. This option would involve disturbance to two sites as opposed to the one site proposed by the Kensington Venture.

Offsite Leaching of Flotation Concentrates

Another milling alternative evaluated involved offsite processing of flotation concentrates. The Kensington Venture has estimated that concentrate tonnage would amount to 4 to 7 percent of the total ore processed, or 160 to 280 tons per day.

The primary advantage to offsite processing of flotation concentrates is that the potential adverse environmental effects of onsite gold processing using cyanide would be eliminated in the area of the mine and flotation plant. This not only includes the potential direct effect of tank cyanidation and associated discharge-related impacts but also the transportation of cyanide and other chemical reagents such as chlorine (for cyanide destruction) to the site.

This option was considered since the Greens Creek Mine on Admiralty Island produces and

transports concentrate offsite. Ore characteristics, however, are very different between the two projects. The Kensington ore is a sulfide and telluride with gold being the only economic mineral. The Greens Creek operation mines sulfide ore with a number of economic minerals such as zinc, lead, copper, silver, and gold. The separation and recovery of these minerals from a concentrate is a sophisticated operation that is generally not completed at the mine site, but rather at offsite large custom smelters. For the most part, these smelters are not located in the United States due to stringent environmental compliance requirements.

For offsite treatment, the concentrates must be prepared for shipment. This would be completed by dewatering with a filter press or belt press. The dewatering system would return water to the flotation circuit and to the tailings pond (DMC, 1990a). The dewatered concentrate would be placed in plastic lined drums holding about 1,000 pounds each. Given the value of the concentrates, particular care must be taken to prevent the loss of concentrates, dilution or other potentially deleterious effects which might affect gold recovery.

Preparing concentrate for shipping offsite would require the following project changes:

- Eliminate CIL circuit, carbon handling and refinery
- Construct pressure filters, thermal dryers, barrel handling and storage

The changes in process area configuration would probably not change the disturbance footprint. Addition of barrel storage would require about 3 to 4 acres (200 ft x 750 ft) of additional disturbance near Comet Beach. Employment at the project would increase to accommodate the labor intensive concentrate handling operations.

These project changes would result in the following environmental changes:

- Increased disturbance
- Increased fuel consumption
- Increased air emissions
- Increased barge traffic to handle concentrate
- Elimination of cyanide handling on site

There is one known site, near Hyder, AK, that, with extensive modification, could accept and treat the concentrate. Shipping concentrate to this facility would result in definite increases (listed above) in some environmental impacts, but would eliminate none. The gain would be the reduction in risk of cyanide spills in Lynn Canal. However, this reduction would be accompanied by corresponding increases near Hyder. The net effect would be an increase in impacts. This option does not appear to offer apparent environmental advantages to warrant further examination.

Offsite Smelting

Offsite treatment by smelting has been considered by the Kensington Venture as an option to flotation and tank cyanidation. It is a variation on the offsite leaching option that would not involve construction of leaching facilities on Forest Service lands. Special 20 ton containers would be required to transport concentrate to an undefined site. There are no known smelters available in North America for this concentrate. Therefore the concentrates would most probably be smelted in Western Europe (DMC, 1990a). This is not a viable option as the volume of concentrate does not warrant consideration by smelters. Transportation reliability is a major constraint to this option.

WASTEWATER TREATMENT

Cyanide Destruction

Industries using cyanide have developed a number of treatment processes for cyanide destruction. Additionally, other processes have been proposed based on related laboratory investigations but will not be considered in this document. These are discussed in in greater detail in JMM (1992).

The most common cyanide treatment processes utilize an oxidizing agent in combination with pH control to eliminate cyanide and metal-cyanide complexes from solution. The Homestake Mining Company at Lead, SD has used a biological oxidation process. Other treatment processes utilizing ozone, ultraviolet irradiation, and chlorine dioxide have been utilized on a

more limited basis or evaluated at the bench and pilot scale.

Several reported systems rely on physical-chemical techniques to remove cyanide, but most of these are considered polishing steps. Adsorption on activated carbon, complexing with ferrous sulfate to lower solubility, ion exchange resins, reverse osmosis, electrodialysis, and high pressure oxidation are all processes that have been used for specific industrial applications or described in the literature as being able to treat or destroy cyanide. They have not been widely practiced in the mining industry.

Table 2-3, Cyanide Treatment Process Not Considered in Detail, presents a summary list of available conventional treatment techniques used to reduce, destroy or stabilize cyanide solutions. The table also summarizes treatment characteristics of each process and gives reasons for not considering the process for the Kensington Project.

Wastewater Treatment for Metals and Suspended Solids

The available laboratory data and subsequent water quality analysis prepared for the Kensington Project indicate that the potential effluent water quality parameters of concern (other than cyanide) are metals and suspended solids. A qualitative comparison of available water treatment processes for mining and milling application must be based upon the specific characteristics of the waste to be treated and the effluent criteria to be achieved. Removal effectiveness, energy and chemical requirements, by-products treatment and residual disposal requirements, and operational simplicity and reliability should all be employed as process screening criteria.

Water treatment processes not studied in detail are shown, along with screening criteria, on *Table 2-4, Alternative Metal Removal Processes*. In addition, a number of proprietary or experimental processes have been reported for metal removal but are not addressed in the EIS.

None of these processes have the proven performance, efficiency, supplier and equipment availability, and reliability and simplicity of operation needed to be considered for use at the Kensington Project (JMM, 1992).

TAILINGS DISPOSAL

Slate Creek

The north fork of Slate Creek is a technically feasible tailings dam site. However, the distance associated with transportation of tailings slurry from the Sherman Creek processing site to the Slate Creek Lakes location limits its feasibility for the proposed Kensington Project. A discussion of the overall site feasibility and environmental constraints is presented in this section.

Slate Creek drains a series of small lakes through a flat terrace to Berners Bay. The impoundment would be located within the upper portion of the drainage basin on a constricted section of the creek.

The drainage basin size is approximately 1.2 square miles (768 acres). The site would require the drainage of two lakes and impact about 188 acres. The depth of unconsolidated material (i.e. peat, sand, gravel) extends to approximately 70 feet in certain areas of the potential impoundment site. The volume of embankment material has been estimated at 236,000 cubic yards for the starter dam and 102,000 cubic yards for the raises during the life of the operation. The dam would be approximately 170 feet in height and 600 feet in length at the crest. The embankment design would entail a low permeability core with coarse material shell. It would accommodate 20 million tons at the final raise.

This option would require construction of approximately 11,750 feet of diversion ditches to route upstream surface water around the facility for discharge into Slate Creek below the embankment. These diversions would be a combination of ditches and pipes to accommodate changes in elevation and control expected flows. (*See Figure 2-16, Slate Creek Tailings Disposal Detail*).

The potential for seepage control problems near the creek channel exists due to unconsolidated materials being present in the embankment foundation. The steep valley walls may also

Table 2-3, Cyanide Treatment Processes Not Considered in Detail

Process	Thiocyanide	Total Cyanide	Method-C Cyanide	Ammonia	Metals	Comments
Inco SO_2/Air	P	Y	Y	n/a	Y	Can be viable alternative to alkaline chlorination for high thiocyanide water, removes iron complexed cyanide. Heavy metals precipitated. Relatively new process but design support from Inco.
Biological	Y	Y	Y	Y	Y	Destroys all forms of cyanide and removes metal. Biological system subject to upset and requires continuous feed, and relatively warm temperature. Economical for treating large volumes of wastewater. Limited commercial experience. Skilled labor required.
Ferrous Sulfide	n/a	P	Y	n/a	N	This process alone may not meet discharge requirements. Does not remove heavy metals. Desorption of cyanides may be a long-term problem. No experience in U.S., limited experience in Canada.
Acidification/ Regeneration	N	Y	Y	n/a	N	Recovers reusable cyanide, heavy metals not removed. May not be cost-effective unless waste stream has high cyanide levels. Proven for cyanide recovery but not waste treatment.
UV/Ozone	Y	Y	Y	n/a	Y	Not proven in the mining industry. Removes all forms of cyanide and heavy metals. High electrical energy costs. High O&M costs if substantial thiocyanide is present. High level of operator experience required.
Ion Exchange	Y	Y	Y	n/a	N	Useful as a polishing step; high removal cost, requires activated carbon pretreatment for organic removal. Skilled operators required. Heavy metals not removed. Not proven in the mining industry. Thiocyanide is irreversibly adsorbed, and poisons the resin. Therefore, should not be used where thiocyanide occurs.
Ferrous Sulfate	?	Y[1]	Y[1]	n/a	N	Produces effluent quality on the order of 1-10 mg/l CN which does not meet the discharge requirements. Does not remove free cyanide or heavy metals. Filtration step required to remove colored precipitate; skilled labor necessary. Process not proven in the mining industry.

Y = Yes, process removes indicated component.
N = No, process does not remove indicated component.
P = Poorly, process not very efficient at removing indicated component.
? = Removal performance was not determined.
n/a = Not applicable
[1]Prussian Blue process does not remove free cyanide, rather it removes complexed cyanide.

Table 2-4, Alternative Metal Removal Processes

Process	General Effectiveness	Pretreatment Required	Comparative Cost (Cap. + O&M)	Advantage	Disadvantage
Chemical Precipitation & Clarification					
Caustic	Good	Yes	Medium	Ease of operation, cost, liquid.	Hazardous, difficult sludge.
MgOH	Lower pH	Yes	Medium	Less hazardous, liquid shipments.	Only low pH limits (8-9), costly.
Sulfide	Variable	Yes	Medium	Specific to some metal (Pb, Zn)	Difficult sludge to dispose (reactive).
Reverse Osmosis	Excellent	Yes	High	Effectively removes most metals.	Brine disposal, membrane life.
Electrodialysis	Excellent	Yes	High	Membrane life improve.	Brine disposal, reactive material.
Ion Exchange	Excellent	Yes	High	Selective metal treatment possible.	Regenerate disposal, reactive material.
Granular Activated Carbon	Good	Yes	Medium-High	Low technology, lower removal effectiveness.	Limited effectiveness, GAC replacement.
Evaporation/Distillation /Crystallization	Excellent	Yes	Very High	Very effective, zero discharge.	Difficult operation, costly O&M, not proven on larger scale, brine disposal.
Electrolytic	Varies	Yes	High	Stabilizes available metals.	High energy cost, metal specific.

contain permeable zones. Based on the results of initial studies, additional seepage control may be required for this site. This could involve cut-off trenches and grouting (Dames & Moore, 1989c).

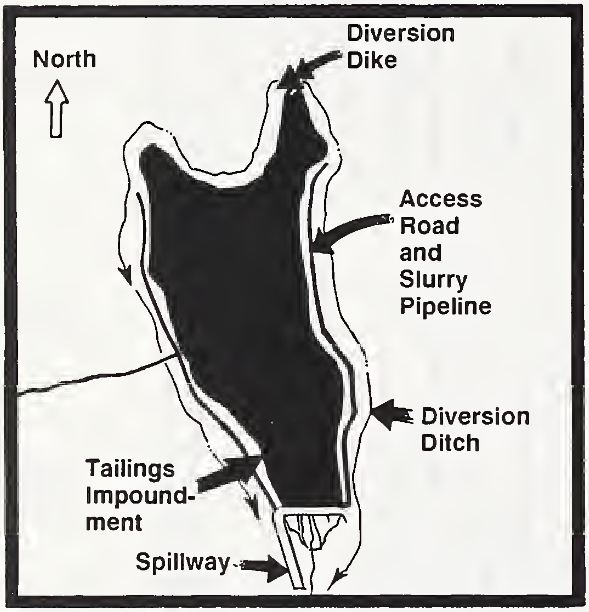


Figure 2-16, Slate Creek Tailings Disposal Detail

Construction material for the embankment would not be available from within the tailings basin. Additional areas would be disturbed to supply this material.

Distance from the mine site precludes use of waste rock for embankment construction. Therefore, offsite quarries would be used through the life of this facility. Approximately 200 total acres of surface disturbance would be associated with the tailings pond and quarries.

The distant location from the mill would also require additional infrastructure to support use of this site. A 54,000 foot long slurry pipeline and return water pipeline with associated pumping stations, spill containment facilities, and leak detection system would be required to transport the tailings from the mill site to Slate Creek Lakes. A parallel service road also would be needed for access, maintenance, and power supply.

Development of the Slate Creek tailings disposal site option could also result in greater undesirable impacts to recreation in Berners Bay, waterfowl habitat, and fisheries resources.

In summary, feasibility of the Slate Creek site for construction of a tailings dam for the Kensington Project is affected by the following considerations:

- Surface disturbance impacts two drainages
- Additional surface disturbance due to access road, pipelines, and offsite material quarries
- Potential for seepage to the ground water
- Increased risk of spills due to pipeline break
- Avalanche hazards exist along the pipeline right-of-way
- Road and pipe alignment traverses extensive wetland areas
- Additional energy required for pumping water back to the surface plant

Independence Lake

Independence Lake is located approximately 3 miles northwest of the proposed mill site. The drainage basin size is about 2.35 square miles (1,404 acres) for this site. Tailings would be transported to this site by slurry pipeline. A new access road, power line, water return line, slurry line, and associated pump stations and spill containment facilities would be required.

Construction of two dams would be required, one at the south inlet and another at the north outlet. Foundation conditions are expected to be difficult due to unconsolidated materials and the steep talus slope along the east side of the site. These conditions would require seepage control by grouting or other methods.

Sources of rock for the construction of the embankment would need to be located. Preliminary studies indicate that material from within the pond area could be used for construction. The embankment volume would be approximately 5 million cubic yards.

The south embankment would initially be constructed to a height of 70 feet, with subsequent raises to a final dam height of 155 feet. The ultimate height of the north dam site would be 235 feet. Total length of each dam would be 1,800 and 1,050 feet for the south and north dam, respectively.

The Independence Lake site requires draining an existing lake and adjacent wetlands prior to construction. In addition, approximately 5,600 feet of diversion ditches and other structures would be required to route surface water around the facility (Dames & Moore, 1989c).

Feasibility of the Independence Lake site is affected by the following considerations:

- Additional surface disturbance due to access road and pipeline
- Seepage control in the foundation which is expected to require extensive grouting
- Increased risk of spills due to potential pipeline breakages
- Disturbance of existing lake and adjacent wetlands
- Disturbance in two drainage basins
- Potential for avalanches and slides in talus slope areas would require significant avalanche control measures
- Construction, maintenance, reclamation, and closure of two embankments

Joint Facilities Options Involving Tailings Disposal

During the Kensington Gold Project EIS public scoping process and development of alternatives for the proposal, several public comments indicated the need to study opportunities as well as cumulative impacts related to joint use of facilities by the Kensington and Jualin Projects. NEPA requires federal agencies to address the environmental impacts resulting from the incremental impacts of the proposed action when added to other past, present, and reasonably foreseeable future actions. The Forest Service has not received a Plan of Operations for development of the Jualin project.

The Jualin project is currently undergoing exploration, according to the operator, Placer Dome U.S., Inc. (Van Nieuwenhuyse, 1991). Plans for this year involve surface mapping and sampling and diamond drilling of several targets located on the claim block. These actions are not connected with the Kensington Gold Project.

The possibility of joint Kensington/Jualin use of tailings disposal facility options assessed for the Kensington Gold Mine Project was evaluated as a means to address potential cumulative impacts. Under this option, Sherman Creek, Slate Creek, or Sweeny Creek disposal sites would be enlarged to handle tailings from both projects, thereby eliminating the potential need for two disposal sites. Similarly, it is conceivable under this scenario that one marine terminal could be used for both projects. That facility option would be located at the proposed Comet Beach site or in Slate Creek Cove. Marine terminal joint facilities options are discussed later in this chapter.

Design capacity and total disturbance associated with the development of any of these sites as a joint disposal facility cannot be adequately evaluated at this time because no operational design proposals have been submitted for the Jualin property. The presence of an economically feasible mineral deposit has not been established. Therefore, certain assumptions were made concerning general project size, configuration, and the overall development schedule to facilitate this study.

Access to the Sherman Creek or Sweeny Creek disposal site options from the Jualin property would require the development of a tunnel approximately 1,500 foot long and additional roads and pipelines from the Johnson Creek drainage to the Sherman or Sweeny Creek drainage. The joint facilities options would provide construction materials and operating supplies via the proposed Comet marine terminal site. (*See Figure 2-17, Joint Facilities*).

With respect to the Sherman Creek joint facilities option, crushing for the Jualin Mine would probably occur at the Jualin Mine site. Crushed ore could then be trucked or conveyed through the tunnel to the grinding and processing facilities at the Sherman Creek site. Assuming acceptable commercial terms could be negotiated by the involved parties, this could be accomplished by a toll milling arrangement with the Kensington Venture. Tailings disposal would occur in the Sherman Creek impoundment.

The primary advantages to joint tailings disposal at Sherman Creek would be the opportunity to effectively contain the tailings and wastewater streams from two projects in a single drainage

basin, (reducing associated cumulative impacts) and providing the opportunity to more carefully monitor and control the two respective waste streams as a single discharge from the milling process. The Applicant has determined that the Sherman Creek site can accommodate at least 30 million tons, which is 10 million tons in excess of the estimated global resource of 20 million tons at the Kensington Gold Project.

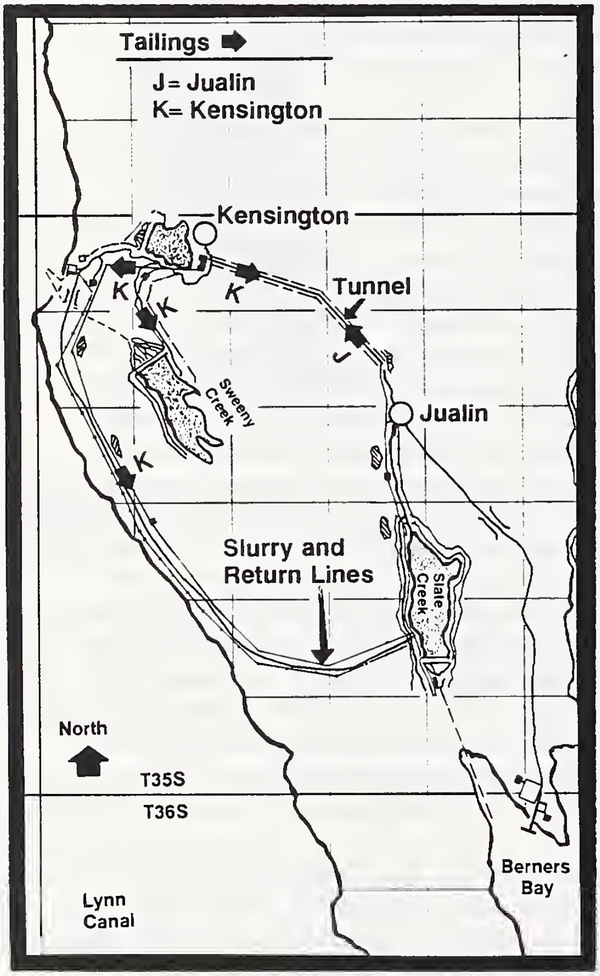


Figure 2-17, Joint Facilities

The Sweeny Creek tailings site also has a total estimated capacity in excess of 30 million tons. Joint facilities disposal at this site would require construction of a 2 mile road and slurry pipeline and related ancillary facilities. Other features and constraints of the Sweeny Creek dam site are described earlier in this chapter.

For the Slate Creek joint facilities option, tailings from the Jualin project could be transported by pipeline in the Johnson Creek drainage and then pumped up to the Slate Creek Lakes site. (*See Figure 2-17, Joint Facilities*).

In addition to environmental and operational considerations indicated for a Slate Creek tailings facility (*see discussion of Slate Creek tailings disposal*), shared facility development raises complex legal, environmental, and operational questions related to joint liability for operation and closure of such a facility under federal and State laws and regulations. These include the following:

- The Kensington Venture cannot assume the risk that the Jualin developers (if and when a project is developed at the Jualin site) would share similar management goals and strategies, as well as production schedules.
- The Jualin property development status is currently too speculative to evaluate joint facilities alternative in detail in the Kensington Gold Project EIS.
- The Jualin property has not completed detailed environmental baseline work or a feasibility study necessary to complete an EIS for the project.
- The two projects are independent, in that development of either project is not dependent on the other.
- From a cumulative impact and mitigation standpoint, impacts related to the disturbance of three drainages, as required for the Johnson Creek/Slate Creek Lakes tailings disposal option, would result in the most significant impacts to Berners Bay users, as well as significant impacts on the Slate Creek Lakes wetlands.
- This proposal could create significant permitting problems with regard to timing of the two projects (i.e., Section 404, EPA NPDES Permits).
- Financial assurance and CERCLA liability considerations as well as the probable requirement for a complex business arrangement, allowing for joint use and cost sharing, may make a joint facilities alternative extremely difficult to implement.

While it Is not possible to predict that a takings under the Fifth Amendment of the United States Constitutlon would be the result of joint facilities, one could result if project owners are forced into uneconomlc commercial arrangements. Therefore, the issue of takings must also be considered under any government imposed joint facilities proposal.

Should a definite mine development proposal be received from the Jualin operator, a subsequent NEPA analysis evaluating this proposal would be prepared by the Forest Service.

Complete Mine Backfill of Tailings

Complete underground disposal of all tailings is technically not feasible. Expansion of rock once drilled, blasted, and ground would preclude complete backfilling of all tailings. In addition, approximately 60 percent of the tailings (the fine fraction) would not be suitable for backfill underground. The Kensington ore has an average in-place volume of 12 to 13 cubic feet per ton, whereas the tailings would average 18 to 22 cubic feet per ton. There is no means of compressing tailings to equal original in-place rock density, therefore, excess tailings would still need to be placed in a location other than mined-out underground stopes. Tailings that could potentially be backfilled at some point in time during the mining schedule would have to be slurried and pumped back to selected stoping areas underground.

Backfilling raises several other key technical feasibility issues for consideration. Power consumption would increase due to dewatering requirements. Water introduced into the mine would require treatment and discharge. Hydraulically placed tailings backfill would need to be cemented. Large quantities of Portland cement, ground slag, and other additives would need to be transported and stored onsite.

Backfilling of Tailings Under the Existing Mine Plan

Use of tailings as backfill in the mine was reviewed. This option would reduce the amount of tailings disposed in the surface facility. Tailings would be separated into fine and coarse fractions. Fine fractions (-200 mesh), about 60 percent of the total tailings, would have to be disposed in the surface impoundment (Knight and Piesold, Ltd., 1991). The fines are not suitable for underground disposal as they dewater very slowly. The remaining 40 percent of tailings, the coarse fraction, could potentially be disposed in the mined-out areas underground, if mining methods conducive to partial backfill were employed for the Kensington Project. This is not the case for the long hole, open stoping method proposed by the Applicant.

Underground mining requires a certain mine geometry to make backfilling with tailings a practical alternative. Mine geometry is controlled in large part by ore body geometry. The geometry of the Kensington ore body and mining method are not favorable for backfilling. The large stopes would be very difficult, if not impossible, to seal. Mining would proceed from the top of the ore body downward. After the first stopes are complete, miners would be working beneath them. Thus, only stopes that can be safely and effectively sealed could be backfilled. Based on the current mine plan, only 35 percent of the total stope area would be available for backfilling. With this limitation on available space, physical characteristics of the tailings and scheduling limitations, it is estimated that only 8 to 12 percent of the total tailings volume could be safely disposed underground (Knight and Piesold, Ltd., 1991).

Backfilling only the portion of the ore (flotation concentrate) treated by the cyanidation process was examined. This was dropped from further analysis for two reasons: 1) the flotation concentrate tailings would consist entirely of fine fractions which dewater very slowly causing stability concerns; and 2) the flotation concentrate represents the pyritic portion (4 to 7 percent) of the tails which could create acid formation problems with mine drainage if it is not recombined and buffered by the remaining tailings (93 to 96 percent).

The reduction in surface disturbance gained by this option would be negligible. Backfilling of 8 to 12 percent of total tailings was considered insignificant when balanced against concerns for worker safety and technical incompatibility with the mining method. This option was dropped from further consideration.

Submarine Tailings Disposal

Originally, the Applicant had proposed this method of tailings disposal but later abandoned it after lengthy discussions and communications with EPA.

On April 19, 1989, the Kensington Venture received a determination from EPA regarding the applicability of New Source Performance Standards (NSPS) of the Clean Water Act to submarine tailings disposal. The determination concluded that "**any discharge of process wastewater in association with mine tailings is covered by Sub-part J of the Ore Mining Regulations, which addressed the zero discharge limitation, and therefore cannot be permitted under the National Pollutant Discharge Elimination System (NPDES) Section 402 program.**"

In determining the scope of alternatives to be considered, emphasis was placed on what is reasonable, rather than on whether the Applicant desires or is capable of carrying out a particular alternative. Reasonable alternatives include those that are technical and economically practical or feasible. Conflicts with local and federal laws do not necessarily render an alternative unreasonable, although such conflicts must be considered.

Because the use of submarine tailings disposal would not be permittable under a NPDES Permit issued pursuant to the Clean Water Act (Section 402), this disposal technique was not the proposed action of the Applicant. However, submarine disposal of tailings appears to represent the only reasonable alternative method to onshore disposal. Therefore, a technical discussion is included for this option.

Submarine disposal of tailings from the Kensington operation could occur in Lynn Canal. A proposed system would consist of a tailings inflow pipe from the mill, a mixing deaeration tank, an outfall pipe, and a seawater intake pipe with a fish screen and flow regulating equipment. (*See Figure 2-18, Submarine Tailings Disposal*).

The deaeration tank would be constructed with its base station below low water level on a concrete foundation anchored to rock. A tailings inlet pipe from the mill would be encased in corrugated steel pipe and covered with riprap for protection. A seawater intake pipe would be fitted with a fish screen at its intake and the outfall pipe anchored by concrete blocks. Lynn Canal is approximately 6.5 miles wide with a maximum depth of over 950 feet. Discharge would occur at a depth of approximately 460 feet some 2,600 feet offshore. Tailings mixed with seawater in the deaeration tank would flow downslope entraining seawater as the plume descended.

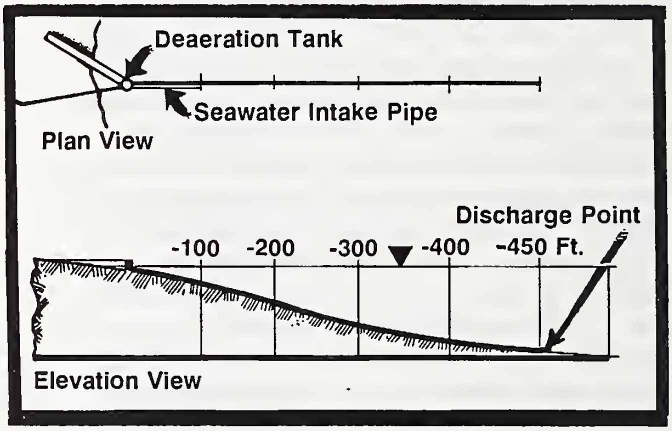


Figure 2-18, Submarine Tailings Disposal

EPA (an EIS cooperating agency) has provided the following discussion regarding the AJ Mine. This logic and finding is applicable to submarine tailings deposition at the Kensington Gold Project.

> **"Section 306 of the Clean Water Act provides for the establishment of national standards of performance for different categories of new sources. These standards establish limits to the discharge of pollutants reflecting the greatest degree of effluent reduction achievable by the application of the best available demonstrated control technology, including standards permitting no discharge of pollutants. Accordingly, EPA promulgated new source performance standards in 1982 for a subcategory of ore mining sources under which the AJ mine project falls (40 CFR 440.104). These standards specifically prohibit the discharge of process wastewater, including any associated pollutants, from**

froth flotation ore mills (the process proposed for the Kensington Gold Project) to waters of the United States. These regulations recognize that "the elimination of the discharge of pollutants to navigable waters may result in an increase in discharges of some pollutants to other media" (40 CFR 440.104(b)(1)). EPA considered these impacts and addressed them in the preamble to the regulation.

The new source performance standards applicable to the ore mining froth flotation process were modeled on facilities which use conventional tailings ponds for disposal of mine solid waste and which serve as holding ponds for recycle, treatment, or evaporation of the process wastewater. EPA considered recycle, through use of tailings ponds, as a demonstrated technology which meets the standard of performance requiring a zero discharge of pollutants. The solid wastes represented by the tailings from the froth flotation milling process were the type of pollutant considered in the promulgation of these guidelines. The removal of mine tailings from the waste stream before recycling of water was an integral part of EPA's determination that existing mining technology could assure the elimination of pollutants and achieve zero discharge.

EPA conducted a thorough review of this issue to determine whether or not flexibility exists within the guidelines and underlying statute to allow the subject discharges to marine waters. It was concluded that, without changes in the statutory framework established by the Clean Water Act, these discharges could not be authorized."

Although the fact that an alternative requires legislative action does not automatically justify excluding it from an EIS, an alternative must also be reasonable. Approval and use of submarine tailings deposition would require Congressional action to amend the Clean Water Act. An alternative that requires Congressional action rarely qualifies for inclusion in an EIS, regardless of the technical reasonableness of the alternative. In this case, Congress has shown increasingly less tolerance for discharge of pollutants into marine waters.

In a June 1, 1990 letter from EPA the Forest Service, the opposition to consideration of submarine disposal of tailings as a reasonable alternative for the forthcoming Kensington DEIS was addressed in the following:

"We have noted that it is our opinion that a thorough or meaningful analysis of submarine tailings disposal as a 'reasonable alternative' cannot be accomplished in the EIS. Although a limited discussion of submarine tailings disposal in the EIS is necessary, a detailed comparison with permittable upland disposal alternatives would not be feasible. Consequently, meaningful conclusions regarding the 'preferability' of submarine tailings disposal could not be drawn, nor would EPA be prepared to comment on those conclusions. This input is provided with our understanding that the range of 'reasonable alternatives' initially identified in the draft scoping document are proposed and remain subject to further review at this early state in the EIS process."

EPA also states:

"Submarine tailings disposal is not an available alternative as it is prohibited under EPA's applicable National Pollutant Discharge Elimination Systems (NPDES) new source performance standards pursuant to the Clean Water Act. It is unlikely that meaningful conclusions regarding the preferability of submarine tailings disposal (in relation to other available alternatives) could be drawn in the DEIS. If this discharge were permittable, much additional information would be requested and reviewed by EPA, and this would need to be reflected in the EIS.

It is also unlikely that a limited discussion of submarine tailings disposal in the DEIS would obviate the need to prepare a supplemental DEIS if at some future date the applicable NPDES rules prohibiting such discharge were changed and a new

project proposal entailing submarine tailings disposal were submitted. Such a rule change, if initiated, would entail a lengthy rule making process."

Considerable effort was spent studying the relative merits and, conversely, the technical, environmental, political, and legal implications of this technique for tailings disposal. As a result, it was decided that a submarine tailings disposal option would not be considered because the likelihood of Congress amending the Clean Water Act to permit such disposal is remote and speculative.

MARINE DISCHARGE

No Mixing Zone

Many comments on the DEIS concerned locating a mixing zone in Lynn Canal. The project is located in a net precipitation area, and thus would need a discharge point. Treatment technology is not able to reduce wastewater pollutant concentrations to marine life standards. The remaining option for eliminating the mixing zone would be to entrain seawater in the effluent stream. If enough seawater could be mixed with the effluent, marine aquatic life standards could be met at the end of the pipe.

At maximum wastewater flows, minimum dilution needs would vary from 29:1 to 88:1. This means that capacity for mixing between 145,000 and 440,000 gpm of seawater would be needed. The installation of a seawater pumping station and mixing plant adequate to handle this volume is not considered feasible due to the volumes involved. Large seawater intake and discharge pipes would be required. One or more additional generators would be required, and fuel use and disturbance would increase at the site. Pollutants discharged to Lynn Canal would not be reduced.

HOUSING AND TRANSPORTATION

Satellite Community

A new townsite or satellite community would function as a largely self-contained entity with workers commuting to work daily from their homes. Individual houses and apartments would need to be constructed for workers and their families. Community facilities would include a school, hospital, recreation center, religious facilities, town administration offices, police and fire stations, super market, and department stores. It is assumed central sewer and water and other utilities would be provided to the townsite. Transportation to the townsite from Juneau or Haines would have to be provided on a routine basis. The complex environmental, economic, and infrastructure requirements associated with the construction and maintenance of a new satellite townsite make this option unfeasible.

Echo Cove Terminal

Another possible option would be construction and use of a ferry terminal in Echo Cove. The existing road (the Glacier Highway) could be extended approximately 3 miles to reach deep water access so that a facility at Echo Cove could be constructed and used in combination with a facility in Slate Creek Cove. Employees could drive to the Echo Cove terminal, be transported across Berners Bay by a ferry, and then be shuttled to the mine by a bus over an 8.5 mile road parallel to Lynn Canal.

A parking area, floating dock, and trestle at Echo Cove would be constructed. In addition, a permanent wave barrier would be installed to protect the floating dock. (*See Figure 2-19, Echo Cove Facility*).

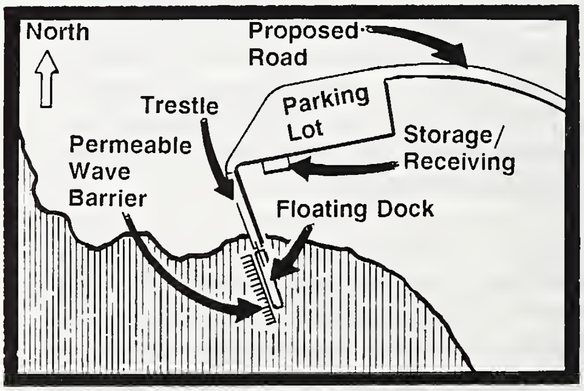


Figure 2-19, Echo Cove Facility

This option adds to the complexity of the project and its infrastructure. A new road, ongoing road maintenance, traffic considerations, and the requirement for

construction of a second marine terminal in this area would affect Echo Cove, which is a favorite recreation site for many Juneau residents.

Comet Beach Terminal and Daily Ferry Commute

A ferry shuttle from Auke Bay to Comet Beach is at least a 2 hour trip up Lynn Canal. This waterway is subject to harsh winter storms from the north and occasional summer storms from the southeast. Docking of a marine ferry at the existing, unprotected Comet Beach would be impacted by these storms. Employee transportation to the site must be reliable, especially during the winter months. Therefore, the use of a marine ferry system to Comet Beach can only be considered if a breakwater is constructed.

The Kensington Venture commissioned a study (PN&D, 1989) to determine the number of days during the winter when waves in Lynn Canal might exceed 2 feet, or the limit which could cause difficulty with barge landings on Comet Beach, or mooring to an all weather dock without a breakwater. This study indicated that reliable daily water transport service could not be guaranteed to the Comet Beach area without the construction of a breakwater.

Originally, the Applicant proposed the use of a breakwater at Comet Beach to assure protection for marine transportation to the site. (*See Figure 2-20, Comet Beach Breakwater*). A major concern identified during the scoping process was that the breakwater at Comet Beach would be an obstruction to migrating salmon and the commercial fishing fleet which commonly fishes near Point Sherman and Comet Beach. Also, the facility would require significant annual maintenance. The study indicated that such construction would be difficult and not economically feasible. A floating breakwater was also considered as an alternative to a rock breakwater but was eliminated as unfeasible due to winter wave action in Lynn Canal.

Slate Creek Cove Common Facilities

An access option that has been mentioned frequently by claim holders at the Jualin project is locating the terminus of a ferry shuttle system in Slate Cove. Under this scenario there would be a road from Slate Cove up Johnson Creek connecting to a tunnel through the ridge that separates Johnson Creek basin from Sherman Creek basin. This road could be used for both the Kensington Project and the Jualin Project if it is developed. At present there are rudimentary elements of this alternative in place. The existing system would have to be rebuilt and greatly expanded to provide the level of service needed for a full scale project.

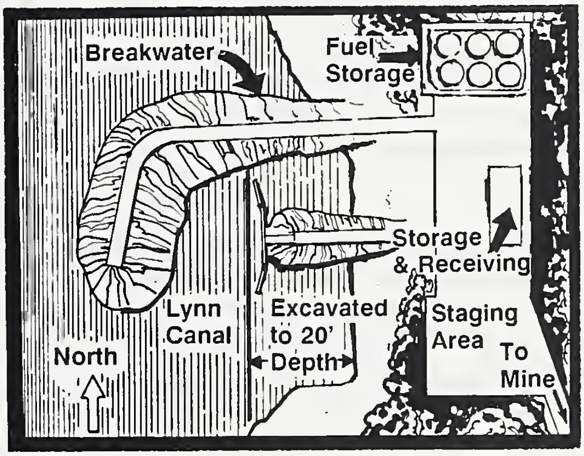


Figure 2-20, Comet Beach Breakwater

The principal attraction of this alternative is that it would provide permanent all weather access to both Kensington and Jualin. Disadvantages of this option are that it would impact Berners Bay and recreation opportunities there. It would spread the disturbance from the Kensington project into three drainages (Sherman, Slate and Johnson). And it does not eliminate the need for a barge landing at Comet to accommodate major construction deliveries.

The EIS recognizes that this option is attractive in terms of reliability and could be used for joint access if Jualin is developed. But the disadvantages of this option make it unattractive for further study at this time.

Air Transport

Float Plane. The ability to land a float plane near the project site on Lynn Canal would be greatly hampered or prohibited during many days in the winter due to large swells and wave action. Float planes can land only in relatively calm seas and would not be a reliable means of

transportation for a full time year-round mining operation. Float planes could not be used to land at night which would further limit winter use. Although some minor use of float planes may occur to provide periodic transport to the site, they do not provide the performance reliability needed for full project service.

Wheeled Fixed-Wing Aircraft. Use of wheeled aircraft would require the construction, operation, and maintenance of an airstrip. A Twin Otter type aircraft, capable of carrying approximately 20 passengers, would require an airstrip 5,500 feet in length. The topography of the Kensington site would require considerable cut and fill construction to build an airstrip. Wetlands would be destroyed during construction and additional wildlife habitat disturbed.

Originally, the Applicant proposed the use of wheeled aircraft and the construction of an airstrip as their preferred approach to employee transportation. (*See Figure 2-21, Airstrip Location*).

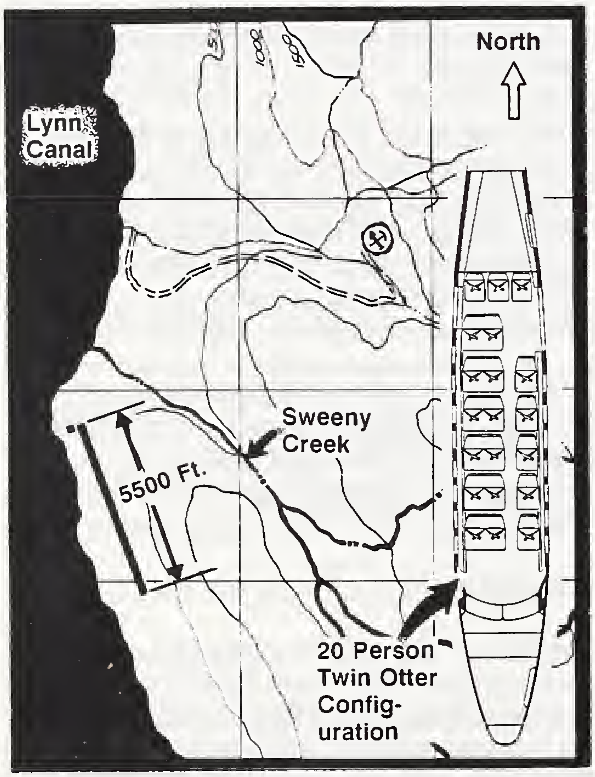


Figure 2-21, Airstrip Location

The Applicant withdrew its proposal for the airstrip based on overall reliability, capital construction costs for a runway, associated safety instrumentation which would be required by the Federal Aviation Administration for fixed-wing aircraft landings, and additional surface disturbance to wetlands and wildlife habitat.

Road Transport

There is no existing overland road system to the proposed operation site from Juneau or other southeast Alaska communities. The Applicant considers construction of a road solely to serve the Kensington operation for transport of personnel or supplies to be prohibitively expensive and outside the scope of this project from both environmental and project standpoints.

The Alaska Department of Transportation released a Scoping Report in March 1990 which addresses access improvements to Juneau. One of the alternatives being considered is the construction and operation of a road that skirts Berners Bay and passes through the Kensington claim block.

Assuming funding is made available for the study, the Alaska Department of Transportation and Public Facilities would prepare an environmental impact statement for this project.

If the alternative which transects the Kensington claim block is selected as the preferred alternative in the Alaska Department of Transportation EIS, detailed right-of-way surveys, additional site-specific environmental studies, engineering studies, final construction designs, and completion of the construction could be expected to take many years. Consideration of a road system from Juneau to the Kensington Gold Project is independent of the proposal, and considered outside the scope analysis.

POWER SUPPLY AND FUEL

Diesel Fuel

The use of diesel fuel to power a turbine generator was initially proposed by the Applicant. This was later changed in favor of LPG turbines. Both diesel and LPG fired

systems could meet ambient air quality standards and applicable increments. This is noted because the operation would be required to use diesel power plant during construction. This would be addressed in the State Air Quality Permit.

Hydropower

Hydropower was considered for power generation. Low winter flows in the drainages above the mine site are insufficient for the volume required to supply the electric generating capacity needed for the project (Ott, 1989). Flow maintenance for fisheries was also an important consideration in this evaluation.

COMPLETE PROJECT ALTERNATIVES

This section describes the project alternatives which have been assembled from potentially feasible component options. These alternatives would be discussed and analyzed in greater detail in *Chapter 4, Environmental Consequences*. The components that are the same for all alternatives, except the No Action Alternative are:

- Mine Area
- Mining Method
- Operating Schedule
- Ore Processing (except grinding)
- Power Supply and Fuel Storage (except location)
- Water Supply
- Solid Waste Disposal
- Sewage Disposal
- Surface Water Control, Except for Permanent Facilities
- Vegetation Clearing and Disposal

Table 2-5, Operational Components and Alternatives Analysis, outlines those operational components and/or options evaluated and combined to form full project alternatives. In summary, the components that vary among the action alternatives include the following:

- Waste Rock Disposal: All alternatives are the same except for Alternative D

Table 2-5, Operational Components and Alternatives Analysis

PART 1 - Operational Components Considered for Detailed Study

- **Mining Methods** - Long hole, open stoping underground mining
- **Waste Rock Disposal** - Temporary stockpiling for construction uses, permanent disposal
- **Crushing** - Underground crushing
- **Grinding** - Surface and underground grinding
- **Flotation** - Surface flotation
- **Cyanidation** - Surface tank cyanidation and carbon adsorption
- **Processing Ore and Concentrate** - Processing at the site
- **Refining** - Onsite, shipment via. helicopter
- **Wastewater Treatment** - Alkaline chlorination, hydrogen peroxide, enhanced settling, effluent filtration and chemical precipitation followed by clarification
- **Tailings Disposal** - Sherman Creek (conventional dam, dry tailings disposal); Sweeny Creek (conventional dam)
- **Housing** - Onsite employee workcamp (Sherman Creek); no on-site housing
- **Transportation** - Helicopters from Juneau airport, helicopters from Yankee/Bridge Cove, daily ferry across Berners Bay
- **Water Supply** - Surface and groundwater
- **Fuel Storage** - Above ground LPG and diesel (temporary during construction)
- **Landfill** - Incineration and barging
- **Sewage Disposal** - Package treatment plant (discharge treated sewage effluent via nearshore and deepwater options)
- **Rock Quarry** - Alternate sites for various alternatives

Table 2-5, Operational Components and Alternatives Analysis (cont'd)

PART 2 - Operational Components Eliminated from Detailed Consideration

- **Mining Methods** - Cut and fill mining; open pit mining
- **Crushing** - Surface crushing
- **Flotation** - Underground flotation
- **Cyanidation** - Underground cyanidation; heap leaching; vat leaching
- **Wastewater Treatment** - SO_2 Air and unproven cyanide destruction processes. Several unproven metals removal processes
- **Processing Ore and Concentrate** - off-site processing; off-site cyanidation; off-site smelting
- **Tailings Disposal** - Slate Creek Lakes; Independence Lake; joint facilities options at Slate Creek Lakes; submarine tailings disposal; complete mine backfill; partial backfill
- **Housing** - Daily commute by ferry (Auk Bay to Slate Creek Cove); Satellite community
- **Power Supply** - hydropower

- Tailings Disposal: Alternatives B, C, and F are the same; Alternatives D and E are different
- Wastewater Treatment: Alternatives C and D are the same; Alternatives B, E, and F are different
- Outfall Location: All alternative are the same except for Alternative F
- Diversions: Alternatives B, C, and F would have the same diversion locations but different construction methods. Alternatives D and E would be different
- Employee Transportation: All alternatives are the same except for Alternatives C and D
- Supply Transport: All alternatives are the same except for Alternative C
- Employee Housing: All alternatives are the same except for alternative C
- Rock Quarry/Borrow Area: All alternatives are different
- Site Reclamation: All alternatives have the same goals
- Generator location: All alternatives are the same except for Alternative D

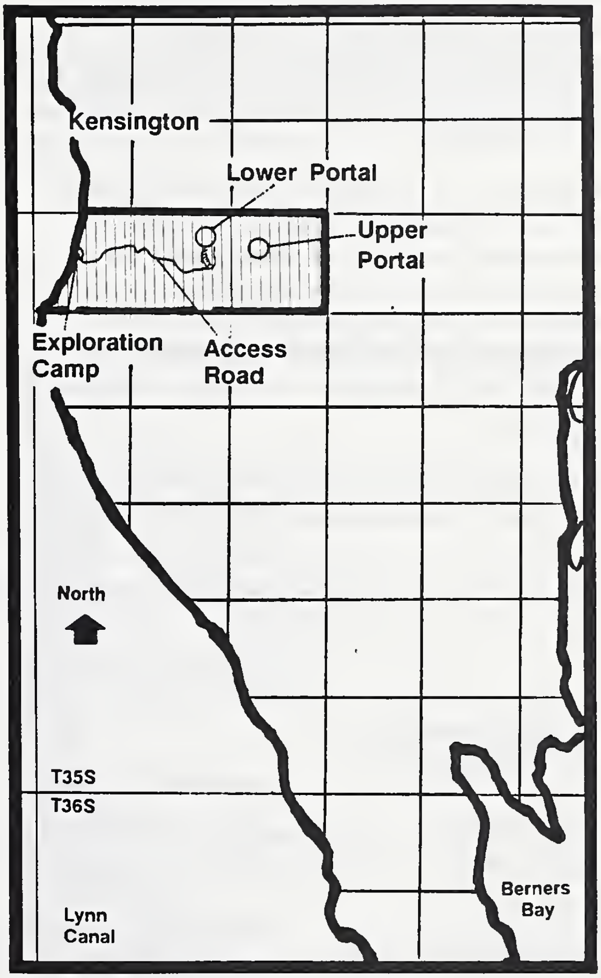
The No Action Alternative and the action alternatives are summarized in the following sections.

ALTERNATIVE A - NO ACTION ALTERNATIVE

This alternative would serve as baseline for estimating the effects of other options (40 CFR 1502.14). Under this alternative, permits would not be granted, and approval for the operation would be denied. This alternative could constitute a taking of private property under the Fifth Amendment to the U.S. constitution.

NEPA requires that a No Action Alternative be considered in all environmental documents. In this instance, the No Action Alternative would preclude the proposed Kensington Venture mining and milling activities on National Forest System lands.

As a result of the No Action Alternative, any facilities and/or operations such as the underground mine, the mill, and the tailings impoundment as proposed by the Kensington Venture on National Forest lands would not be developed. Exploration activities could continue under previous Forest Service approvals and Environmental Assessments. Since the Kensington Venture has patented mining claims, they would retain certain rights. The patented claims are private property and would not revert to Forest Service administration.



ALTERNATIVE B - APPLICANT PROPOSAL

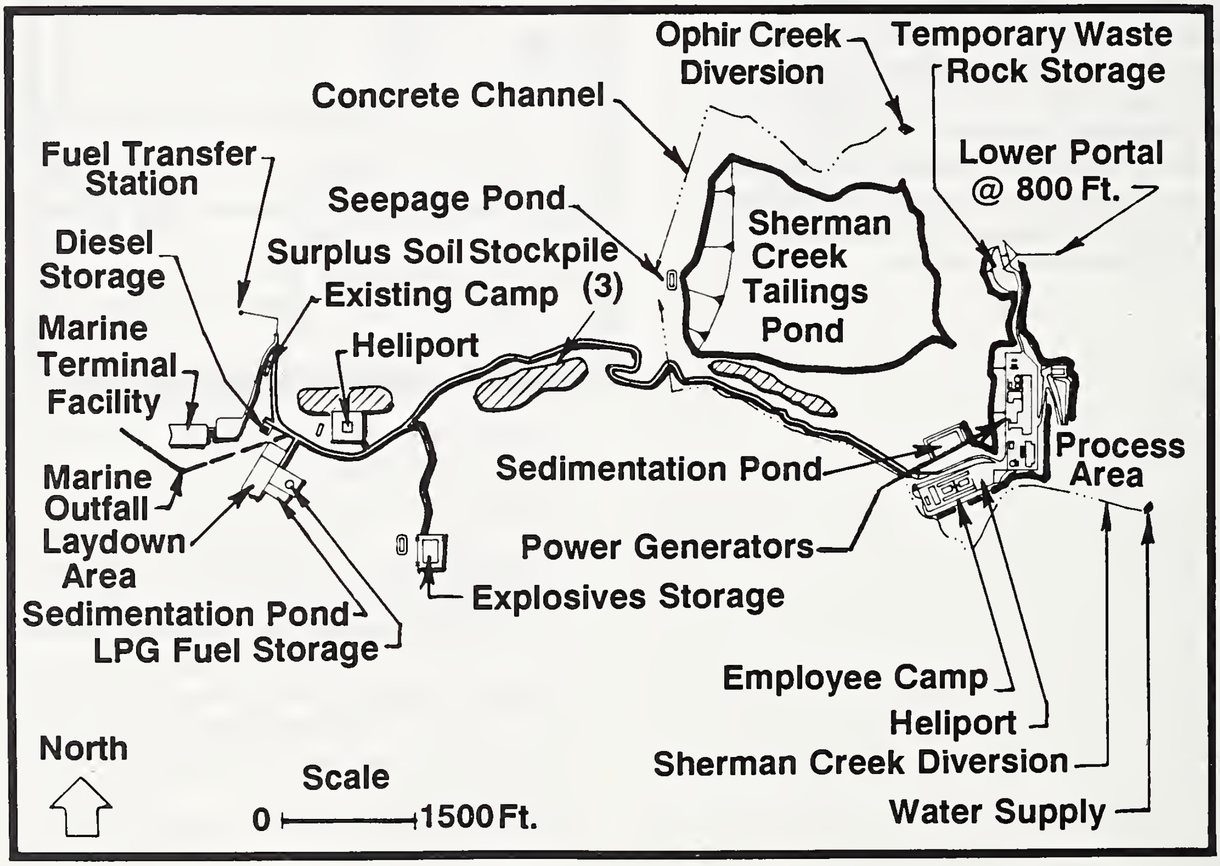
This alternative represents the construction, operation, and reclamation of a mining and milling facility as proposed by the Applicant. All disturbance would be confined to the Sherman Creek drainage.

Alternative B would consist of an underground mine, an ore processing facility, an office and maintenance complex, an onsite employee camp, heliport/helipads, a Comet Beach marine terminal, and ancillary facilities such as an access road between the marine terminal and the mine, a fuel storage area, and an explosives magazine.

During full production, the Kensington Gold Mine would process approximately 4,000 tons of ore per day. Ore would be mined by the underground extraction technique of long hole, open stoping. The mine would be accessed by an adit approximately 1 mile in length. An estimated 400 tons of underground development waste rock per day would be hauled to the surface using small diesel powered trucks. This waste material would be used to construct a cross valley tailings pond embankment in Sherman Creek, road base, and facility foundations.

An estimated 340 people would be employed at the project during full production. An employee housing camp would be constructed onsite. Tentative work schedules would require at least half of the full complement of work personnel to be onsite at any one time.

Employees would be transported to the project site by helicopter. Supplies and fuel would be transported by barge to a marine terminal at Comet Beach.



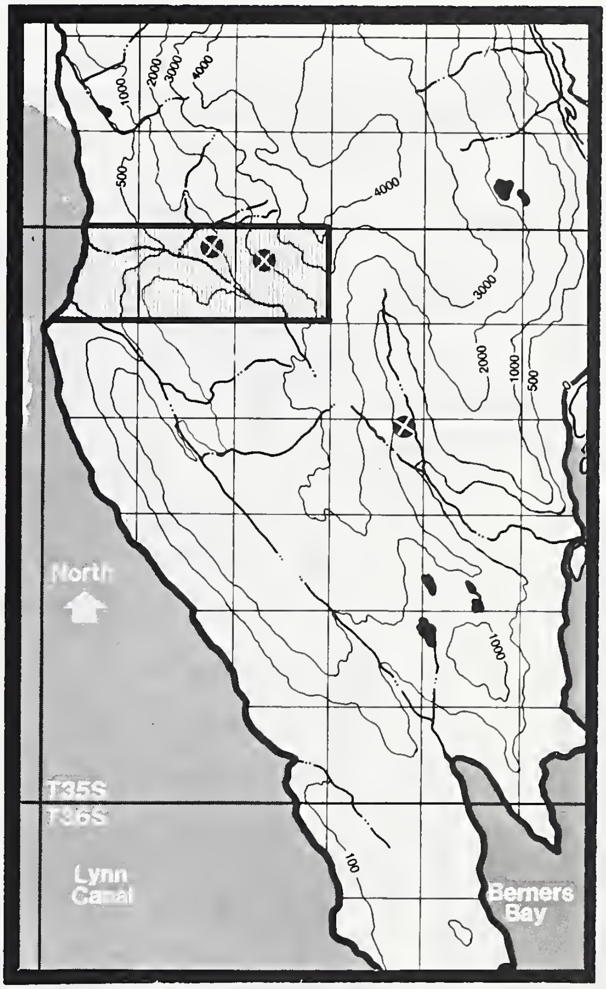
Conventional milling techniques within enclosed structures on the surface would be utilized. Coarse ore would be stockpiled adjacent to the mill facilities in an enclosed structure. Initially, the ore would pass through a flotation circuit where the gold bearing minerals would be separated from barren rock. Gold would be recovered from the flotation concentrate (representing 4 to 7 percent of the ore) by standard tank cyanidation methods to produce gold bullion. Tailings (rock material from which gold has been extracted) would be treated to destroy cyanide and pumped to the tailings pond. Water used in the process would be recycled. Ophir Creek would be diverted around the tailings impoundment in an open, concrete lined channel. Sherman Creek would be diverted through a culvert.

The Kensington operation has a projected life of approximately 16 years. Construction activities would take approximately 2 years; gold production would occur for the next 12 years; decommissioning and reclamation would occur during the last 2 years.

The marine outfall is located north of Point Sherman. The pipe would be buried through the tidal zone to a depth that would avoid wave damage. From there the pipe would be laid on the bottom to a diffuser location. Diffuser design would vary with depth.

ALTERNATIVE B COMPONENTS

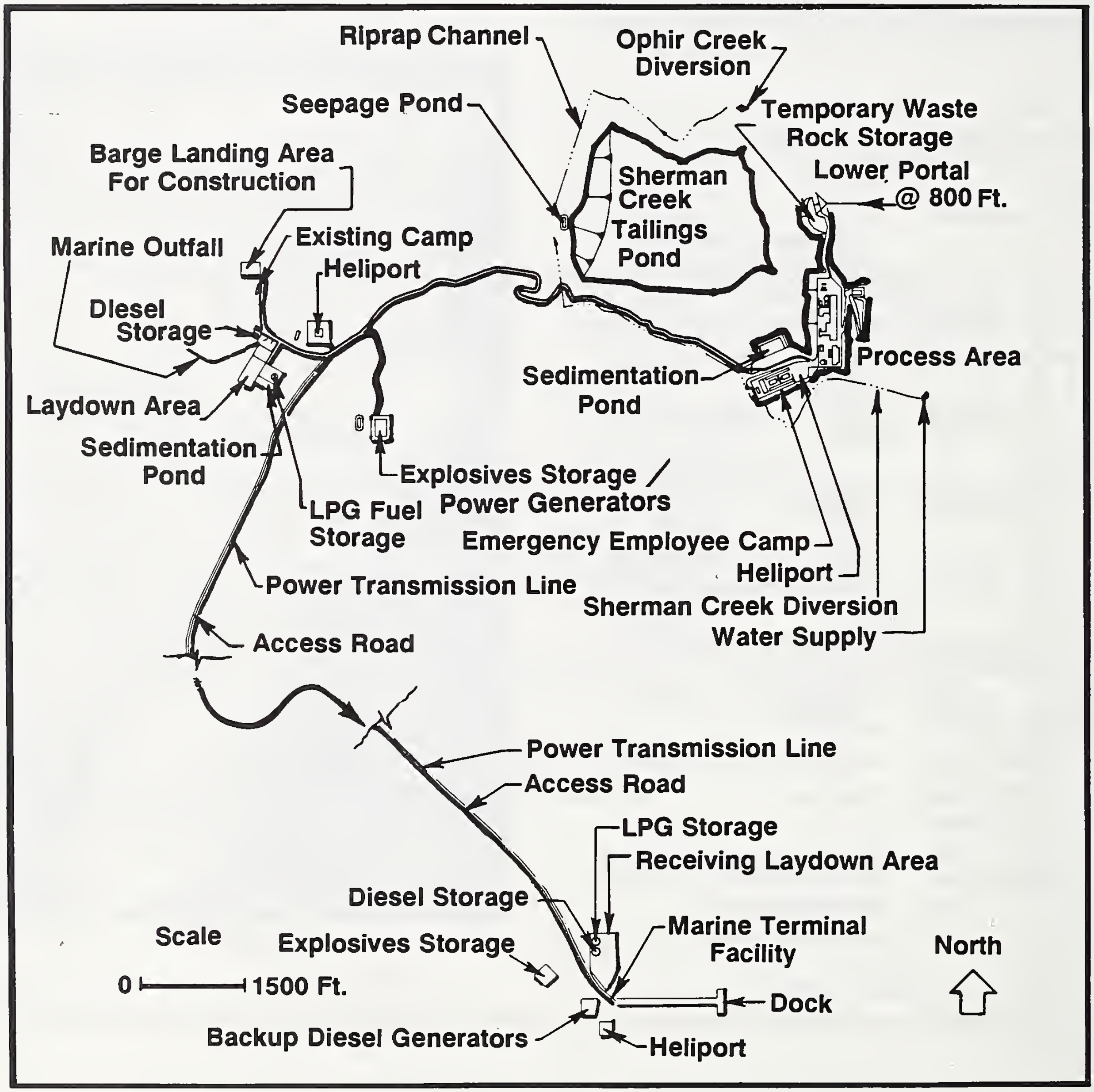
Waste Rock	400 tons of rock per day for use in tailings embankment and road construction. Temporary stockpile near lower portal
Grinding	SAG mill and ball mill on surface
Tailings Disposal	Cross valley (centerline) dam in Sherman Creek
Diversions	Diversion of Sherman and Ophir creeks
Mill Wastewater Treatment	Alkaline chlorination and tailings pond settling
Excess Water Disposal	Discharge through marine outfall to mixing zone north of Point Sherman
Employee Transportation	Helicopter from the Juneau airport
Supply Transportation	Tug/barge to Comet Beach, no breakwater
Power Supply	LPG turbines at mill - 2 needed
Employee Housing	Onsite camp
Rock Quarry/Borrow Area	Material extracted from within tailings confinement. Other sites developed in needed



ALTERNATIVE C - BERNERS BAY ACCESS

This alternative represents the construction, operation, and reclamation of a mining and milling facility with long-term access to the site for employees and supplies from a marine terminal facility at Slate Creek Cove in Berners Bay. Disturbance would be concentrated in the Sherman Creek drainage, but an 8.5 mile long access road would be required from the mine site to Slate Creek Cove, where the marine terminal would be located.

The road would parallel Lynn Canal and affect approximately 105 acres. The entire alignment traverses wetlands. Construction material for the road would be mined from six quarries. The 250 person housing camp would not be required, however, smaller onsite facilities would be maintained to provide food service to employees, housing for construction workers, and emergency housing should weather



preclude daily transport of employees. Employees (approximately 170) would be transported daily by ferry from Juneau to the Slate Creek Cove terminal site and bused to the mine.

All supplies, except LPG, would be trucked from the marine terminal to the mine site. LPG would be piped to the power plant via a buried pipeline constructed along the access road.

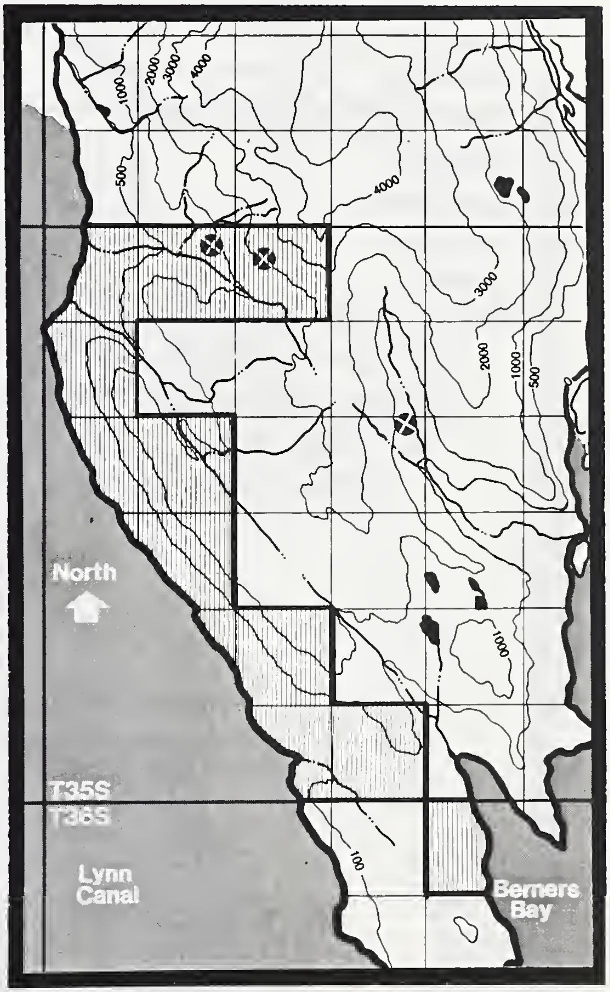
The marine terminal to be located at Slate Creek Cove would involve construction of a combined breakwater and dock/barge landing facility. The facility would include dolphin anchors and a transfer ramp and bridge for off-loading fuel and supplies. This would provide high reliability for both barge service and the high speed ferry used to transport the workforce.

ALTERNATIVE C COMPONENTS

Mining	Underground by Long Hole Open Stoping
Waste Rock	400 tons of rock per day for use in tailings embankment and road construction. Temporary stockpile near lower portal
Grinding	SAG mill and ball mill on surface
Tailings Disposal	Cross valley (centerline) dam in Sherman Creek
Diversions	Diversion of Sherman and Ophir creeks
Mill Wastewater Treatment	Alkaline chlorination/dechlorination and enhanced tailings pond settling
Excess Water Disposal	Discharge through marine outfall to mixing zone north of Point Sherman
Employee Transportation	Ferry to Slate Creek Cove
Supply Transportation	Slate Creek Cove facility
Power Supply	LPG turbines at mill - 2 needed
Employee Housing	Onsite camp for emergency use only
Rock Quarry/Borrow Area	Within tailings confinement, several along road

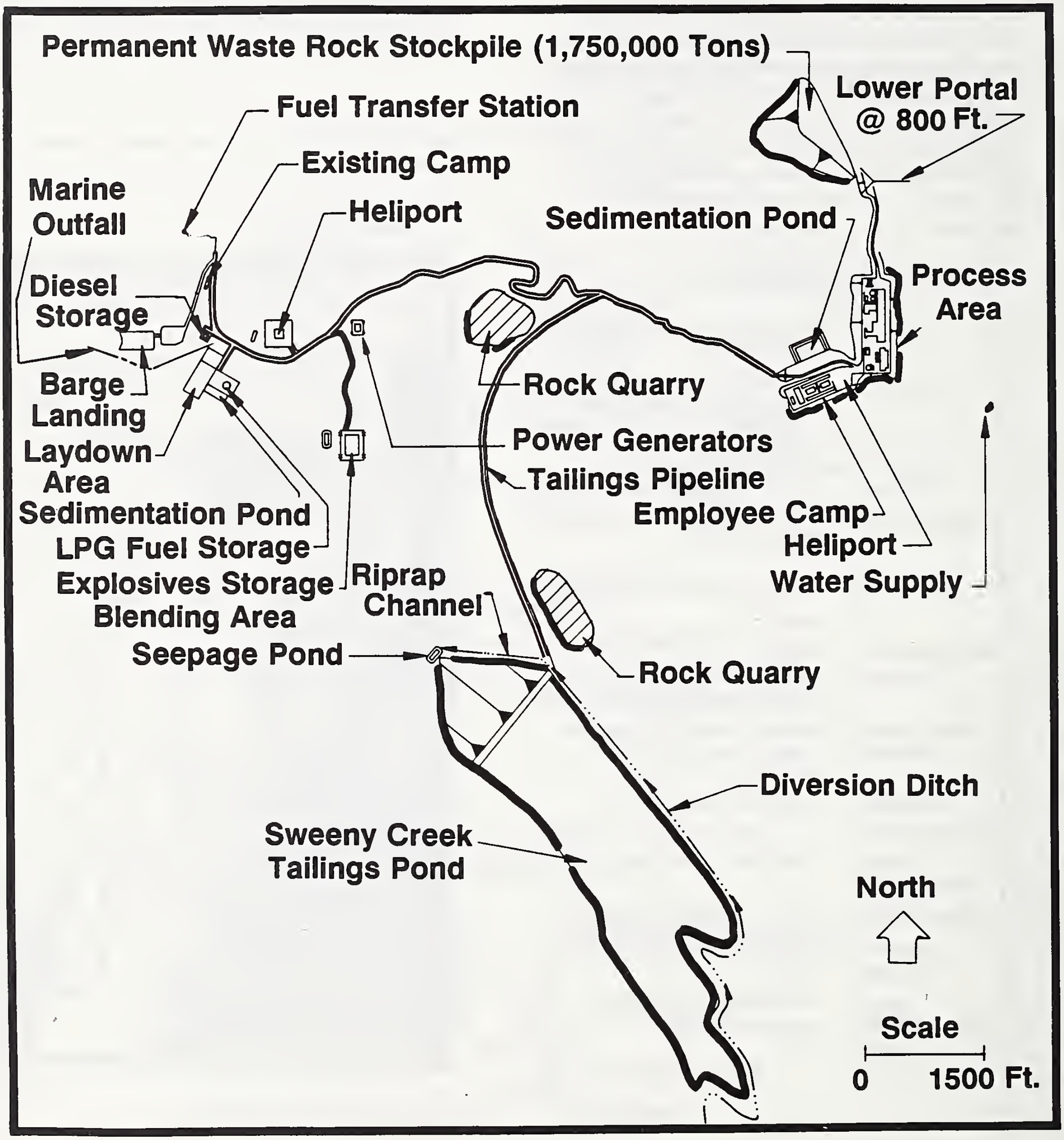
The Ophir Creek diversion would be in a riprap lined channel around the tailings impoundment. Otherwise, tailings disposal would be as described under Alternative B.

The marine outfall would be located north of Point Sherman as described for Alternative B.



ALTERNATIVE D - SWEENY CREEK TAILINGS

This alternative is similar to Alternative B except that tailings would be placed in a cross valley tailings impoundment constructed in Sweeny Creek. In addition, the ore grinding circuit would be constructed in an underground excavation. Diverted flows in the Sweeny Creek drainage would be returned to Sweeny Creek below the dam via a riprap lined channel rather than a concrete lined channel as the Applicant has proposed for Alternative B. Employees would travel to the site via helicopters. The heliport would be located on Glacier Highway between Yankee and Bridget Coves.



Sweeny Creek flows from the southeast to the northwest and discharges into a bay of Lynn Canal about 3,200 feet south of Comet Beach. The creek is in a steep-sided narrow valley. The topography lends itself to a large potential capacity, and the site has a nearby rock source for dam construction. An estimated 3.12 million cubic yards would be required to construct the final tailings embankment.

The tailings dam at this site would be approximately 370 feet high. The ditch required to divert Sweeny Creek is estimated at 15,400 feet.

Constructing a tailings impoundment at this site would result in disturbance in two drainages. The site provides storage potential for more than 20 million tons and is located relatively close to the mine site. A 2 mile slurry pipeline and road would be required for this option.

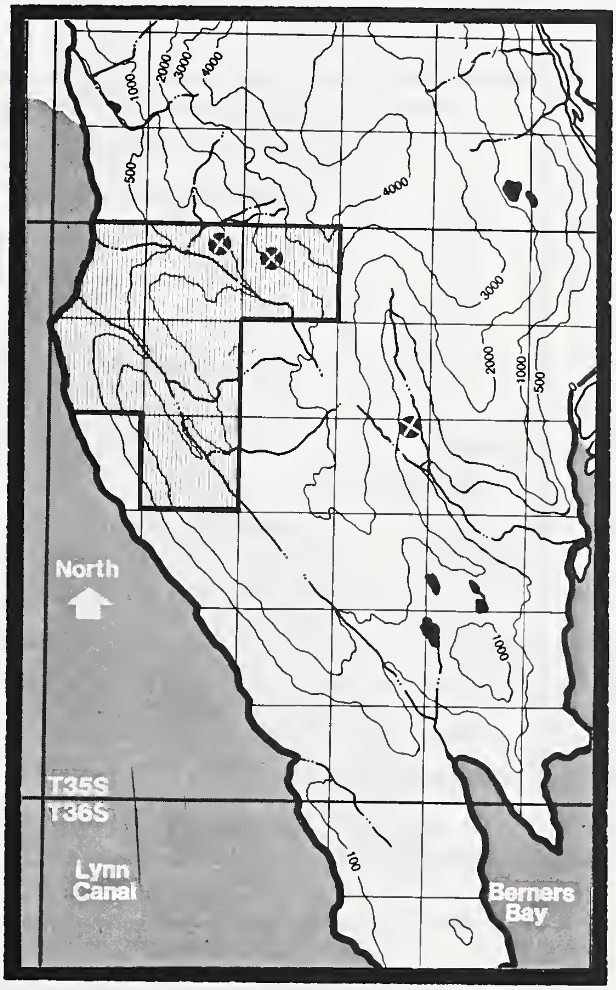
All tailings starter dam construction materials would come from quarries near the dam site. Waste rock would be hauled 2 miles from the lower portal to the dam for subsequent raises. Dam raises would not use all the waste rock so a permanent stockpile of about 612,000 cubic yards of waste would be needed near the lower portal.

Underground excavations would be used to accommodate the ore grinding circuits. The fine ore storage, SAG mill and ball mill would be housed underground. Several conveyors, transfer chutes, pumps, pipelines and other material handling apparatus would also be underground to complete the grinding circuit. A slurry pipeline would transfer ore to the recovery circuits on the surface.

The generator facility would be located about 500 feet east of the heliport as opposed to being adjacent to the facilities as proposed by the Applicant for Alternative B.

ALTERNATIVE D COMPONENTS

Waste Rock	Road construction and permanent stockpile near lower portal
Grinding	SAG mill and ball mill underground
Tailings Disposal	Cross valley (centerline) dam in Sweeny Creek
Diversion	Diversion of Sweeny Creek
Mill Wastewater Treatment	Alkaline chlorination/dechlorination and enhanced tailings pond settling
Excess Water Disposal	Discharge through marine outfall to mixing zone north of Point Sherman
Employee Transportation	Helicopter from Yankee/Bridget Cove
Supply Transportation	Tug/barge to Comet Beach no breakwater
Power Supply	LPG turbines near Comet Beach - 2 needed
Employee Housing	Onsite camp
Rock Quarry/Borrow Area	Quarry near tailings dam



ALTERNATIVE E - DEWATERED TAILINGS

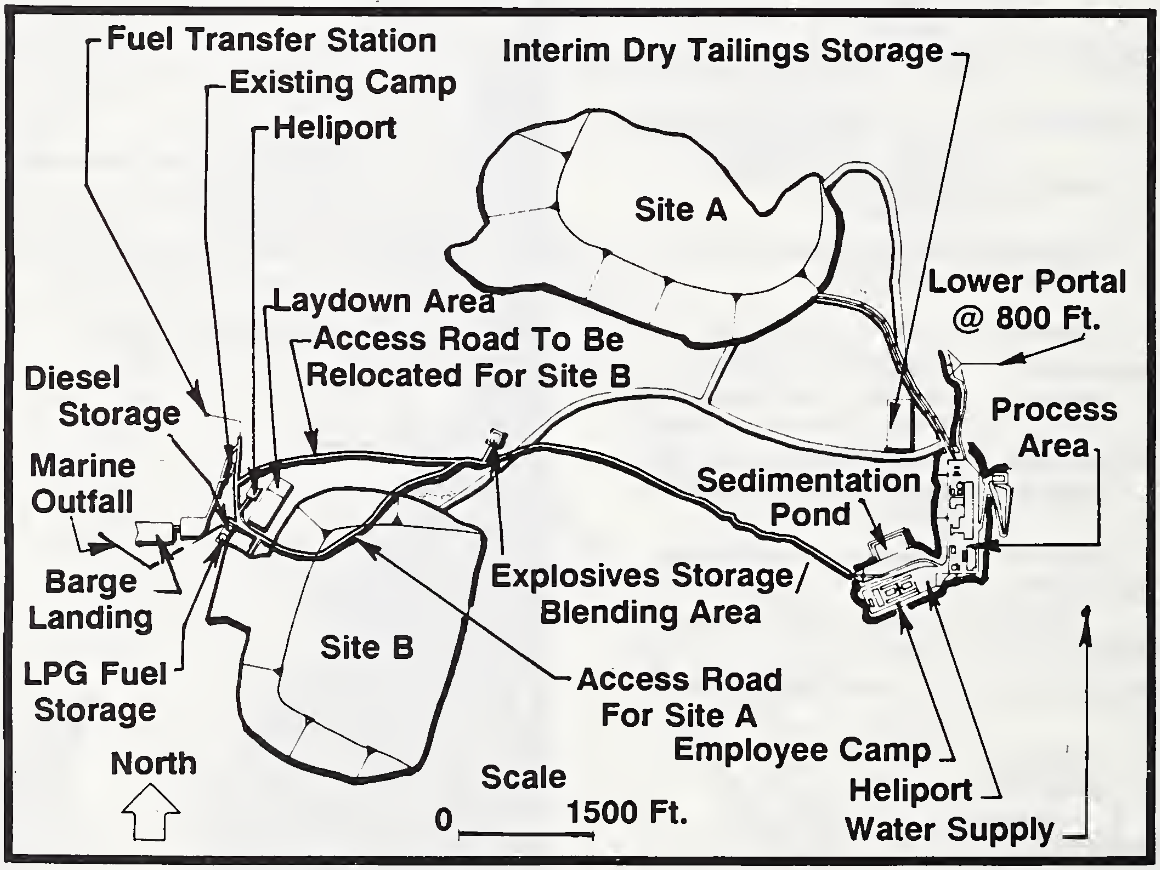
Alternative E is similar to Alternative B except that the tailings would be dewatered prior to disposal. Dewatering would be performed by using filter presses and thermal dryers to reduce the moisture content to a maximum of 14 percent.

Dewatered tailings would be hauled directly to the disposal site or placed temporarily in a storage building during inclement weather. The dewatered tailings are very moisture sensitive. During periods when precipitation reaches or exceeds 0.25 inches, the tailings would have to be placed in covered storage.

Two potential disposal sites have been identified. Site A is located on the valley slope on the north side of Sherman Creek. Site B is located on the moderate slopes adjacent to Lynn Canal, between Sherman Creek and Sweeny Creek. The overall area of disturbance would be approximately 170 acres for site A and approximately 154 acres for site B.

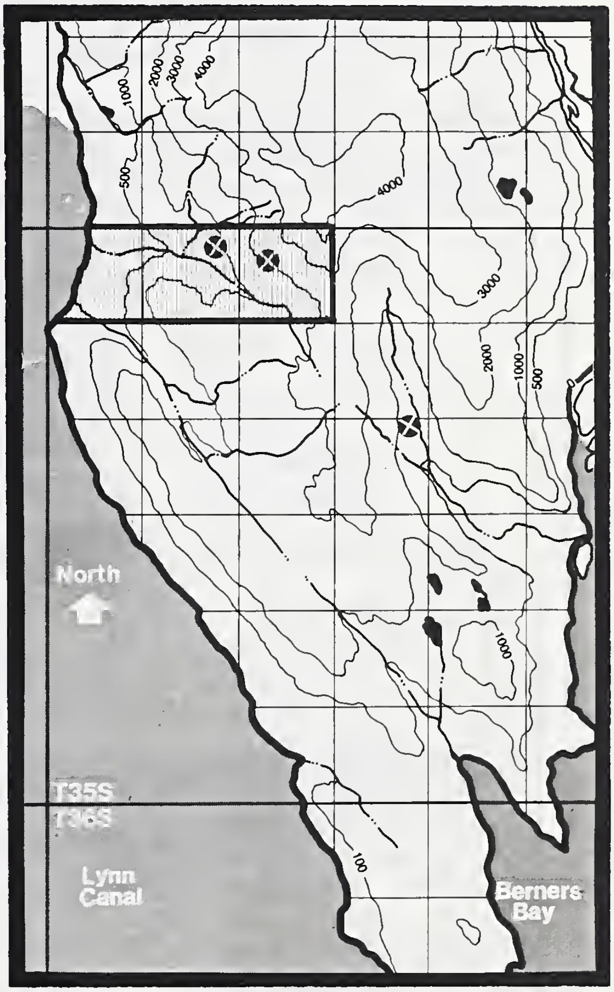
The conceptual construction design is identical for each site and includes:

- An initial containment berm at the toe of the structure constructed using waste rock and borrow material
- A till liner constructed with an overlying drainage blanket
- A decant system to control surface runoff from the structures
- A diversion ditch above the structure to route runoff around the structure
- A sediment pond to collect all flows from the decant, drainage blanket and toe perimeter ditch
- Interior haul roads constructed of waste rock at 75 to 100 foot intervals
- A waste rock buttress up the face of the structure



ALTERNATIVE E COMPONENTS

Waste Rock	400 tons of rock per day for use in tailings embankment and road construction. Temporary stockpile near lower portal
Grinding	SAG mill and ball mill on surface
Tailings Disposal	Dry disposal - site A or site B
Diversions	Upland flow diverted around tailings
Mill Wastewater Treatment	Hydrogen peroxide and settling ponds
Excess Water Disposal	Discharge though marine outfall to mixing zone north of Point Sherman
Employee Transportation	Helicopter from Juneau Airport
Supply Transportation	Tug/barge to Comet Beach, no breakwater
Power Supply	LPG turbines at mill - 3 needed
Employee Housing	Onsite camp
Rock Quarry/Borrow Area	Quarry near facilities area in Sherman Creek drainage



ALTERNATIVE-F ENHANCED EFFLUENT TREATMENT

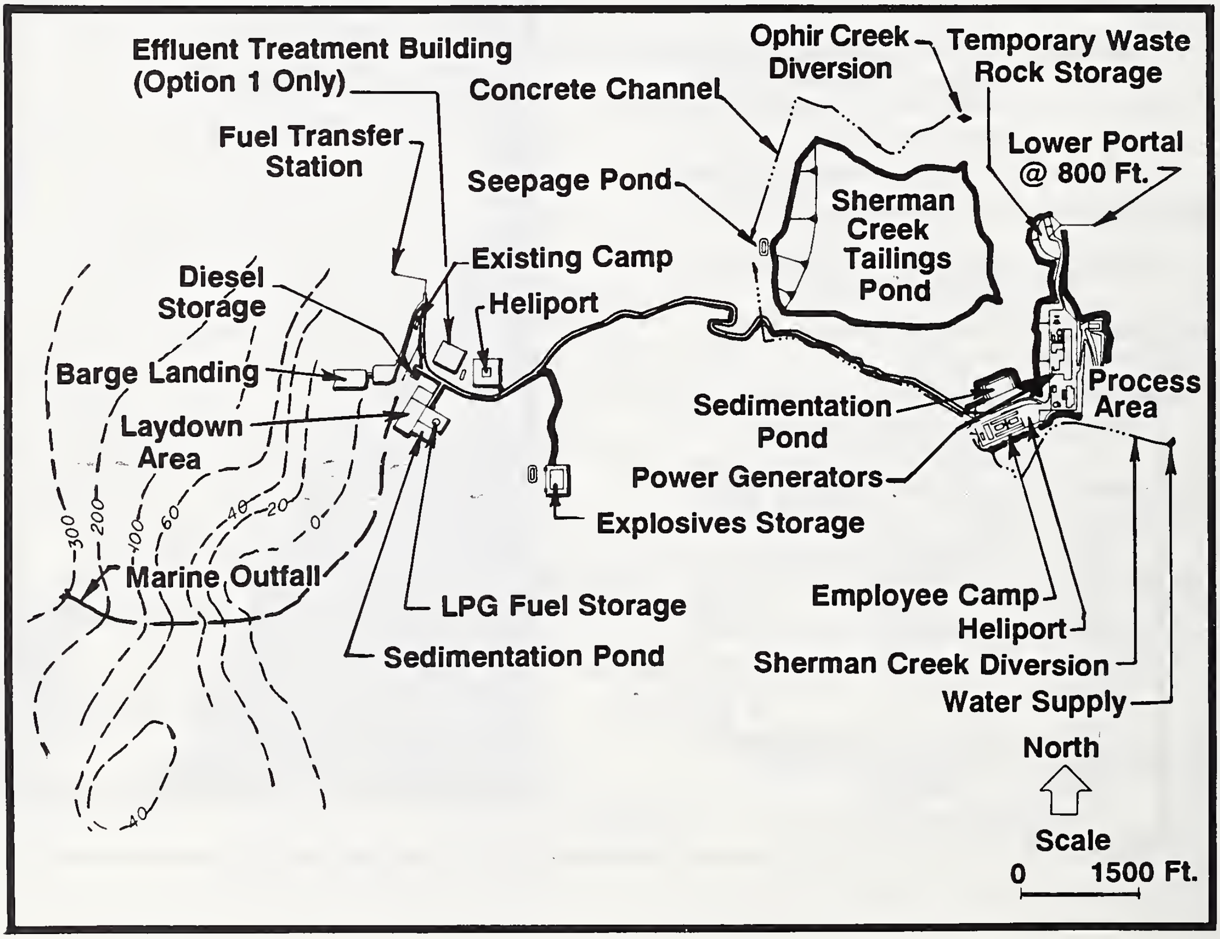
Alternative F is similar to Alternative B with two important exceptions; the marine discharge line is routed to an alignment south of Point Sherman and there is additional wastewater treatment.

The discharge line is routed along the alignment originally proposed by the Kensington Venture from the Sherman Creek tailings impoundment to a point above tidewater. Above tidewater the line turns south and follows the beach to a point south of the neck of Point Sherman. Once south of Point Sherman the line follows a natural bathymetric low to the discharge point. The line would be located above the mean high tide line except where it heads seaward.

Three options for wastewater treatment are considered for this alternative. Option 1 would use alkaline chlorination for cyanide removal followed by dechlorination. Removal of metals and solids in the tailings pond would be enhanced through flocculation, water management, and baffling of the pond.

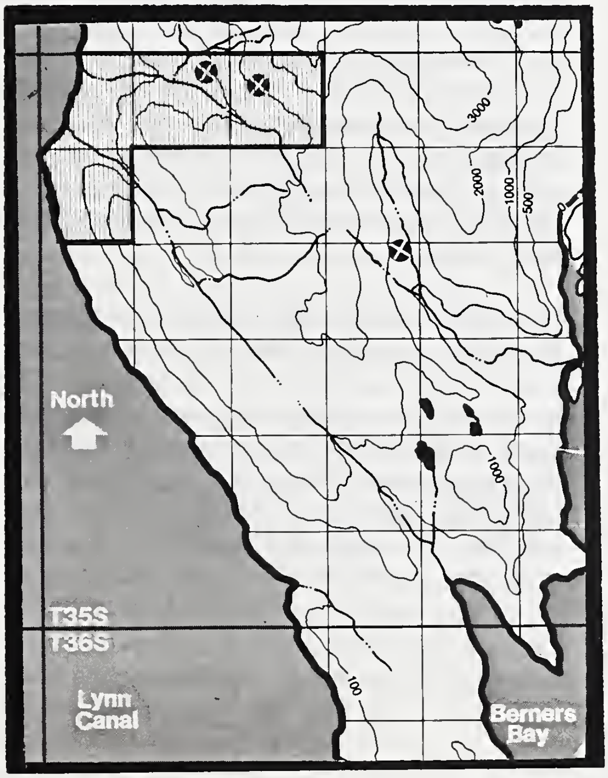
Option 2 would incorporate the components of Option 1 and would add filtration of the tailings pond effluent prior to discharge to Lynn Canal. Filtration would remove all particulates down to about 25 microns. A simplified flow diagram is provided with the site layout map.

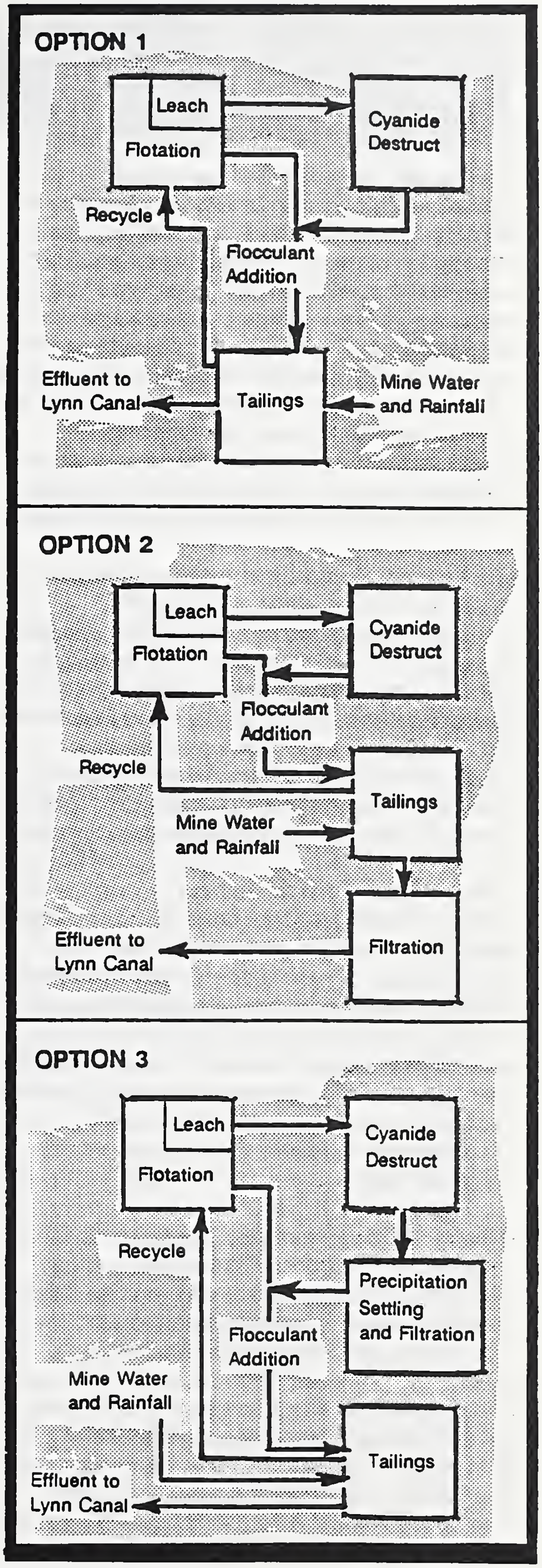
Option 3 would dewater the leach tailings prior to cyanide destruction using hydrogen peroxide. Leach tailings wastewater would be treated using chemical precipitation and settling to remove metals from this stream. The treated wastewater would be recombined with flotation circuit tailings and routed to the tailings pond. Flocculation, water management, and baffling would be used in the tailings pond. A simplified flow diagram is provided with the site layout map.



ALTERNATIVE F COMPONENTS

Waste Rock	400 tons of rock per day for use in tailings embankment and road construction. Temporary stockpile near lower portal
Grinding	SAG mill and ball mill on surface
Tailings Disposal	Cross valley (centerline) dam in Sherman Creek
Diversions	Diversion of Sherman and Ophir Creeks
Mill Wastewater Treatment	Three options: Alkaline chlorination, enhanced settling, effluent filtration, and hydrogen peroxide with chemical precipitation of leach circuit tails
Excess Water Disposal	Discharge though marine outfall to mixing zone south of Point Sherman
Employee Transportation	Helicopter from Juneau Airport
Supply Transportation	Tug/barge to Comet Beach, no breakwater
Power Supply	LPG turbines at mill - 2 needed
Sewage Disposal	Onsite package treatment plant
Employee Housing	Onsite camp
Rock Quarry/Borrow Area	Quarry near facilities area in Sherman Creek drainage





MANAGEMENT, MITIGATION, AND MONITORING

This section describes measures and techniques that lessen or eliminate impacts for all of the proposed alternatives. It includes a discussion of management requirements that would be employed by the Kensington Venture, assuming that one of the action alternatives were selected. In addition to the reclamation and mitigation measures described below, there are environmental requirements associated with various permits, licenses and approvals necessary for the project. The management, mitigation, and monitoring constraints described here are included in assessing project impacts.

Environmental management and mitigation measures are designed to ensure that environmental impacts are minimized during the construction and operation of the Kensington Gold Project. The activities would also be designed such that the site would be reclaimed to a productive use following closure and decommissioning. Implementation of these measures would enhance the project's ability to operate in an environmentally sound manner.

The purpose of the monitoring program is to collect data to verify projected impacts, evaluate mitigation measures, and assess the effectiveness of reclamation efforts. The results of the monitoring and mitigation programs would be reviewed by the regulatory agencies and the Kensington Venture. If environmental changes vary significantly from those predicted, additional remedial measures may be implemented to reduce or eliminate project related effects.

This NEPA documentation must describe the effects of the proposed alternatives on the environment. For the action alternatives, that description is dependent, in part, on the management, mitigation, and monitoring programs proposed for the project. If the No Action Alternative is selected, management, mitigation, and monitoring outlined here would not be required. Instead, the reclamation plan approved by the Forest Service for project exploration would be implemented. If an action alternative is selected, the Kensington Venture must acquire the permits summarized in Chapter 1 prior to initiating project construction and operation. These permits would contain additional specific management, mitigation, and monitoring prescriptions for the project, in addition to those issued in the Record of Decision (ROD). Enforcement of these measures would then be the responsibility of the agencies issuing the permits. The most comprehensive, although not all encompassing, permit required for the Kensington Project is the Forest Service approval of the final Plan of Operations.

The Forest Service land stewardship policy is to protect and maintain soil and water resources, and related beneficial uses. Forest Service management is responsive to the environmental intent and directives contained in the Clean Water Act. Site specific mitigation measures called Best Management Practices (BMP) would be incorporated into the Kensington Project Plan of Operations for control of non-point source water pollution. The Alaska Region Soil and Water Conservation Handbook FSH 2509.22-91-1, section 17.3 would be the framework used to develop site specific BMPs for the Kensington Project.

ISSUES AND MITIGATION MEASURES COMMON TO ALL ACTION ALTERNATIVES

The Kensington Venture would develop a Plan of Operations which contains a reclamation plan to include major mitigation features which facilitate pollution prevention, minimize erosion, and promote concurrent rehabilitation of disturbed areas not required in operation of the mine and mill.

The Applicant Proposal contains an extensive listing of management and mitigation practices that would be applied to the Kensington Project. Following is a summary of measures that would form the framework for development of detailed mitigation measures as part of the Plan of Operations regardless of the action alternative selected. The measures are directed at protecting specific environmental resources.

Land Use Issues

- Loss or disruption of wildlife habitats
- Reclamation to implement LUD II planning objectives
- Financial assurance for planned reclamation activities

Land Use Mitigation

- Minimize vegetation clearing by limiting surface disturbance to those areas absolutely necessary to conduct mining operations and monitoring impacts on an ongoing basis
- Implement Forest Service approved BMPs for sediment control

Water Quantity and Quality Issues

- Minimum flow rates in streams
- Water quality impacts from increases in sediment load
- Water quality impacts from increases in sediment loads
- Water quality contamination by milling reagents, fuels, or other chemicals
- Water quality contamination by sanitary wastes

Water Quantity and Quality Mitigation

Mitigation measures which maintain or improve water quality are referred to as BMPs.

The Plan of Operations will include additional detail on BMPs, as required by the NPDES Permit, and on site specific BMPs for non-point runoff. The framework used to develop site specific non-point BMPs is the USFS R-10 Soil and Water Conservation Handbook FSH 2509.22-91-1. BMPs referenced below are from this source.

Project Planning and Design. Soil, water, and riparian resource considerations have been incorporated into planning and design of the mill and mine site through the EIS process (BMP 17.1, 17.3, 12.6, 14.2).

Protection of Surface Waters from Mill Wastes. Runoff from the mine, from the mill site, and mill effluent will not be discharged to freshwater streams (BMP 17.3).

A seepage pond will be constructed below the tailings impoundment to collect and return seepage (BMP 17.3)

Protect outfall pipe from damage by rockfall and landslides in high-risk areas between impoundment and marine outfall.

Divert ground water inflow to the tailings pond to the extent possible.

Construction Sediment Control. Stream flows will be diverted around the impoundment site during construction of the impoundment (BMP 14.15).

Stream bank stability will be controlled by sizing of stream diversions, and lining of spillways (BMP 12.7).

Bridge and culvert installation will be conducted using methods to minimizes sediment to streams (BMP 14.17).

Borrow pits and quarries will be developed with methods that minimize sedimentation (BMP 14.18).

Ground disturbance will be conducted in weather which minimizes sedimentation to streams (BMP 14.6).

Operations Sediment Control. An erosion control plan for the roads will be included in the Plan of Operations (BMP 14.15). At a minimum this plan will address the following measures:

Stabilization of the surfaces of travel areas with practices such as graveling or paving (BMP 14.21, 14.22, and 14.25)

Control of eroding material by sediment collection traps or directing flow into a tailings pond

Stabilization of disturbed areas with mulch, revegetation, or other similar methods in a timely manner (BMP 12.17, 14.11)

Roads will be maintained in a manner which minimizes rutting, failures, sidecasting, and blockage of drainage facilities (BMP 14.9, 14.20)

Removal of snow from roads to minimize sedimentation from embankments (BMP 14.23)

Oil Pollution Prevention. Runoff from fuel storage tanks will be bermed. This water and mine runoff will be run through an oil/water separator (BMP 12.8).

Barge and fuel offloading procedures will be managed according to an SPCC plan (BMP 12.9).

Sanitary and Solid Waste. Effluent from sanitary facilities will be treated with secondary treatment plant and discharged in accordance with an NPDES Permit.

Solid waste will be managed in accordance with the State Solid Waste Permit (BMP 12.16).

Water Intake. During low flows in Sherman Creek, domestic and mill water supply system will use mine and ground water to maintain required instream flow levels in Sherman Creek.

Hazardous or Toxic Waste Prevention. As required by the NPDES Permit, a BMP plan shall be established to prevent or mitigate toxic pollutants or hazardous substances from damaging the aquatic environment. This program may include requirements for the SPCC plans by reference.

Fish and Wildlife Issues

- Stream habitat loss
- Stream habitat degradation
- Concern for chemical spills or catastrophic tailings dam failure
- Terrestrial habitat disruption for:
  - mountain goat
  - black bear
  - bald eagle
- Bioaccumulation of toxic substances
- Impact on commercial fisheries
- Noise impacts on mountain goats and black bears

Fish and Wildlife Mitigation

- Water Quality and Quantity Mitigation would address impacts to stream habitat (see preceding section)
- Implement an employee education program in wildlife management
- Prohibit employees from hunting, trapping and harassing wildlife in the project area
- Implement a disciplinary program for employees violating fish and game regulations
- Construct fencing around hazardous areas as needed
- Establish buffer zones around bald eagle nests in consultation with USFWS
- Implement an SPCC Plan
- Restore mountain goat herd (by reintroduction after mine closure) if all mountain goats are displaced or die as a result of mine operations
- Implement a bear and garbage management plan in coordination with ADF&G
- Utilize helicopter flight paths that would avoid bald eagle nest sites and mountain goat habitat when weather and safety conditions permit
- Develop flight guidelines for helicopter use near sensitive mountain goat habitat
- Time heavy construction in mountain goat habitat to coincide with non-critical times for mountain goats
- Implement nest season timing restrictions for helicopter use and blasting near bald eagle next sites
- Establish revegetation test plots to evaluate the most effective means of reclaiming wildlife habitat after project closure
- Develop long-term revegetation measures to improve wildlife habitat such as thinning of second-growth forest in reclaimed areas
- Insulate power plant building and orient turbine air inlets and cooling towers on west side of building to minimize noise impacts to mountain goat habitat.

Recreation, Visibility, and Public Access Issues

- Increased traffic in Berners Bay
- Increased noise and visual impacts in Berners Bay
- Visual impacts in Lynn Canal

Recreation, Visibility and Public Access Mitigation

- Protect public access except in the immediate project area
- Leave as many trees as possible standing in place to absorb noise and provide visual screening
- Use of earth tones on building exteriors
- Revegetate the external tailings slopes as soon as practicable
- Direct exterior lighting inward, where possible, to reduce glare and visual impacts

Air Quality Issues

- Fugitive dust and gaseous emissions

Air Quality Mitigation

- Utilize water sprays and bag houses on crushing and screening facilities as appropriate
- Conduct watering of roads or dewatered tailings structure as needed

Socioeconomic Issues

- Population increases
- Impacts on housing
- Impacts on services
- Impacts on lifestyles, including subsistence
- Shutdown effects

Socioeconomics Mitigation

- Provide employment information to City and Borough of Juneau and City of Haines
- Maximize local hiring, as practicable
- Sponsor mining vocational training at University of Alaska Southeast

MONITORING MEASURES COMMON TO ALL ACTION ALTERNATIVES

Monitoring would determine the effects of the project and the efficacy of mitigation measures. It would provide valuable input to regulatory agencies about project performance. And the information gained in monitoring would be used as the basis for designing additional mitigation, if needed.

Water Monitoring Objectives

Monitoring will be conducted to ensure that mitigation measures described in the EIS are implemented, and to evaluate their effectiveness in meeting the NPDES Permit for marine discharges, and in maintaining the water quality in other waters. Additional monitoring will validate the assumptions and predictions of the EIS, and to collect additional data needed for design of specific reclamation features. Specific objectives are:

- Determine whether instream flows are adequately maintained.
- Determine if surface runoff from tailings and waste rock storage facilities, or seepage below tailings impoundment is affecting surface or ground water quality in the project area.
- Determine if accidental spills of petroleum products or hazardous materials affect ground or surface water quality.
- Determine if non-point sediment sources associated with construction or maintenance activities affect surface water quality and to evaluate the effectiveness of BMPs in controlling erosion sources and downstream sedimentation.
- Monitor stream channel stability, particularly in areas associated with channel diversions, and tailings impoundment.
- Determine if reclamation measures such as revegetation of tailings; waste rock piles; or overburden storage are effective, both in the short term and long-term, in controlling erosion, restoring natural watershed conditions and stream flow regimes.
- Evaluate changes or trends in water quality data gathered at sampling sites in affected areas.
- Maintain integrity of outfall pipe

Aquatic Resources Monitoring Objectives

- Ensure that effluent discharge into marine environment has no negative effect on marine organisms.
- Determine effects of mine construction and operation on freshwater aquatic habitats.
- Determine effects of mine construction and operation on salmonid fish use of affected freshwater streams.

Wildlife Monitoring Objectives

- Determine black bear and mountain goat movement and habitat use patterns in relation to mining activities. (bear and goat telemetry - ADF&G, behavioral/time budget observation - USFS)
- Determine if bioaccumulation is occurring in terrestrial mammals (mink tissue sampling/toxicology - ADF&G)
- Determine eagle response to mining/aircraft activity (USFS and USFWS monitoring)
- Track sea lion response to aircraft activity associated with the mining project (USFS and NMFS monitoring)
- Determine noise levels of various activities (noise level monitoring - USFS)

Timber Monitoring Objectives

Assure compliance with terms of timber sale.

Visual Quality Monitoring Objectives

Monitoring will be conducted to determine the extent to which the project contrasts with the surrounding characteristic landscape which is managed for its wildland character.

Geotechnical Monitoring Objectives

- Assure that tailings structure is constructed according to design.
- Assure that tailings structure is maintained in a stable condition over the short and long term.
- Assure that waste rock storage areas are stable over the short and long term.
- Assure that stream diversion channel and spillway are maintained in a stable condition.

Detailed Monitoring Plans

Specific, detailed monitoring plans would be developed that must be in place prior to project approval. The plans would address the above monitoring objectives and include the measures listed on *Table 2-6, Kensington Monitoring Plan*.

Water quality is arguably the single most sensitive issue surrounding the project. Detailed water monitoring plans would be developed and implemented as part of the NPDES Permit and the Plan of Operations. The following proposed structure illustrates the level of detail expected in this and other plans.

- Purpose and Monitoring Objectives
- Network Design
  - Station location
  - Parameter selection
  - Sampling frequency
  - Sampling duration
  - Sample collection and preservation techniques
- Laboratory Procedures
  - Analysis techniques
  - Quality control and assurance procedures
  - Data recording standards
- Data Handling
  - Data screening and verification
  - Database maintenance
  - Data reporting and distribution
- Data Analysis Needs
  - Summary statistics
  - Water quality indices
  - Trend analysis
  - Quality control interpretation
- Monitoring Evaluation
  - Establish evaluation criteria (State water quality standards, NPDES requirements) that would invoke implementation of additional mitigation measures
  - Provide feedback for review and, if necessary, modification of the monitoring network design

RECLAMATION COMMON TO ALL ACTION ALTERNATIVES

The purpose of reclamation is to return the disturbed areas to a stabilized and productive condition following mining and milling activities and protect long-term land and water resources in the area. Forest Service reclamation policy is to ensure prompt reclamation of lands to productive uses consistent with land management policies. An approved reclamation plan must be part of the final Plan of Operations approved by the Forest Service. The plan would describe in detail measures to reduce long term impacts and return the land to a productive state. It would conform to the Alaska Reclamation Act and subsequent regulations.

Table 2-6, Kensington Monitoring Plan

Resource/Item to Measure	How	Frequency of Measurement	Threshold of Variablity	Action to be Taken	Authority	Responsible Staff
Water						
Effluent treatment measures	Inspect implementation of design and mitigation measures outlined in the Plan of Operations, the EIS, and the SPCC Plan	Ongoing	Operability of measures at all times	No discharge of effluent to receiving waters until measures are implemented	ROD/SPCC	KV with FS review
Implementation of Best Management Practices (BMPs) to control non-point pollution from sediment, petroleum products, and hazardous or toxic wastes during construction and operation	Review of site specific BMP plans and inspection of the implementation of these plans	During const. - ongoing During oper. - monthly	Evidence that BMPs are not correctly designed and implemented	Require additional or improved pollution control measures	ROD/Plan of Operations	FS
Effluent compliance with NPDES Permit	Methods according to NPDES Permit	Frequency according to NPDES Permit	Thresholds at NPDES criteria	Notify as required by NPDES Permit and Plan of Operations. The operating company will implement additional measures to correct the parameter which is out of compliance	EPA	KV
Cyanide, chlorine, and pH levels in the mill discharge	Monitor effluent as it leaves the mill	Ongoing	When values exceed levels predicted in the EIS	Determine why variation is occurring, and if it has additional unpredicted effects	ROD/Plan of Operations	KV with FS Review

Table 2-6, Kensington Monitoring Plan (cont'd)

Resource/Item to Measure	How	Frequency of Measurement	Threshold of Variability	Action to be Taken	Authority	Responsible Staff
Water cont'd						
Effectiveness of BMPs in controlling non-point pollution during construction and operation	Collect data on relevant water quality parameters from sites located above and below sites being developed. Sampling sites will differ between construction and operational phases	During const. - collect data in accordance with rate of construction During oper. - varying from weekly to quarterly depending on the site, and the year after construction	Evidence that non-point pollution control measures are not correctly installed, or operationally maintained	Require additional or improved pollution control measures	ROD/Plan of Operations	KV with FS review
Effectiveness of impoundment and seepage control structures in maintaining or improving the water quality in fish-bearing streams below the impoundment	Sample groundwater, seepage pond and stream below impoundment, sampling standard parameters and with biomonitoring	Monthly to quarterly	Flow quantities exceeding the amounts predicted in the EIS. Quality exceeds background levels in streams	Take action to intercept seepage around or under tailings pond	ROD/Plan of Operations	KV with FS review
Maintenance of minimum flows in Sherman Creek	Monitor streamflows at diversion	As established by ADNR instream flow permit	Instream flow levels set by ADNR Permit	Limit water withdrawal to levels established by ADNR Permit	ROD/ADNR	KV with FS review
Compliance with stormwater regulations	Sample according to stormwater permit	According to stormwater permit	Per stormwater permit	Per stormwater permit	EPA Regulations	KV with FS review
Effectiveness of reclamation measures in maintaining water quality below minesite	Monitor above and below the mill and impoundments	Vary with time after reclamation	Background levels	Additional reclamation work	ROD/Plan of Operations	KV with FS review

Table 2-6, Kensington Monitoring Plan (cont'd)

Resource/Item to Measure	How	Frequency of Measurement	Threshold of Variability	Action to be Taken	Authority	Responsible Staff
Water cont'd						
Effectiveness of reclamation in maintaining stable, self maintaining stream channels	Monitor reclaimed channels for stability	Vary with time after reclamation	Self maintaining, productive channels	Additional reclamation work	ROD/Plan of Operations	KV with FS review
Metals and acid levels from waste rock	Sample runoff from waste rock storage areas, and road runoff	Monthly for the first two years	If metals and acid levels exceeds ambient freshwater standards, or background levels	Increase control of stormwater runoff from these areas	ROD/Plan of Operations	KV with FS review
Long-term bedload and sediment transport in diverted streams	Measure bedload transport through sediment traps above stream diversions	Empty and measure sediment traps monthly		Data compiled for use; no action needed	ROD/Plan of Operations	KV with FS review
Water quality and quantity at control stations	Sample sites selected to be controls for other sampling	Monthly		Data compiled for use; no action needed	ROD/Plan of Operations	KV with FS review
Tailings composition	Sample surface and subsurface sediments on exposed tailings	Annually	N/A	N/A	ROD	KV with FS review
Outfall pipe integrity	Visual inspection Pressure monitor for major breaks	Annually Continuous	Pipe leakage	Shutdown discharge; repair pipe	EPA	KV with ADEC/FS review

Table 2-6, Kensington Monitoring Plan (cont'd)

Resource/Item to Measure	How	Frequency of Measurement	Threshold of Variability	Action to be Taken	Authority	Responsible Staff
Aquatic Resources						
Discharge effect on marine organisms	Bioassays near outfall. To be determined in NPDES Permit	To be determined in NPDES Permit	To be determined in NPDES Permit	To be determined in NPDES Permit	NPDES	ADEC, EPA
Spawning salmon escapement survey	Spawner counts using established procedures (Konopacky Project #004-00)	Yearly	When results of this monitoring, in addition to other information, indicate habitat capabilities are changing as a result of mine activities	Meet with District Ranger, Biologists, and Co. Rep. to discuss potential problem. Could result in change in construction or operation practices and mitigation in nearby streams	Plan of Operations	ADEC, EPA
Benthic macroinvertebrate community composition	Benthos sampling from known sites. Using established procedures (Konopacky Project #004-00)	Yearly	Same as above	Same as above	Plan of Operations	KV with FS review
Spawning gravel composition and embryo survival	Using established procedures (Konopacky Project #004-00)	Yearly	Same as above	Same as above	Plan of Operations	KV with FS review
Water temperature	Using established procedures (Konopacky Project #004-00)	Yearly	Same as above	Same as above	Plan of Operations	KV with FS review
Aquatic habitat characteristics	Using established procedures (Konopacky Project #004-00)	Yearly	Trend develops showing reduction in spawning gravels	Same as above	Plan of Operations	KV with FS review

Table 2-6, Kensington Monitoring Plan (cont'd)

Resource/Item to Measure	How	Frequency of Measurement	Threshold of Variability	Action to be Taken	Authority	Responsible Staff
Wildlife						
Eagle nest management	Visit nest sites	Years 1 & 2 - project development every month May - August. After second year, annually	A change (an occupied nest Is no longer occupied) due to mining related activity	Consult with USFWS, USFS & company to modify activity if it is deemed that specific activity is influencing the observed change (nest abandonment)	Eagle Projection Act Plan of Operations	FS/USFWS
Steller sea lions, marine mammals (seals)	Observe known haulout sites	Annually while activities are occurring during times haulouts occupied	Evidence of harassment of marine mammals as direct result of mine-related activities	Enforce Marine Mammal Protection Act	Marine Mammal Protection Act Endangered Species Act/Plan of Operations	FS/NMFS
Black bear monitoring	Track radio collared bears (8)	At least once a month as weather permits through 1993	Evidence of extreme adverse reaction to mining-related activities causing abandonment of habitat	Consult to minimize disturbance. If disturbance cannot be minimized causing losses to bear population-mitigation could involve reintroduction	Contract with KV/Plan of Operations	ADF&G
Mountain goat monitoring	Track radio collared goats	At least once a month as weather permits through 1993	Evidence of extreme adverse reaction to mining-related activities causing abandonment of habitat	Consult to minimize disturbance. If disturbance cannot be minimized causing loss of mountain goat population-mitigation could involve reintroduction	Contract with KV/Plan of Operations	ADF&G
Mountain goat monitoring - continued	Noise monitoring and behavioral/time budget data	Years 1 & 2 - project development/ construction - all summer during operation twice monthly, spring, summer and fall	Evidence of dramatic movement (range abandonment)	Consult to minimize disturbance. If disturbance cannot be minimized, causing losses to goat pop. mitigation would involve goat relocation at end of project	Contract with KV/Plan of Operations	USFS

Table 2-6, Kensington Monitoring Plan (cont'd)

Resource/Item to Measure	How	Frequency of Measurement	Threshold of Variability	Action to be Taken	Authority	Responsible Staff
Wildlife cont'd						
Body tissue monitoring (bioaccumulation)	Collect mink	Annually	Evidence of bioaccumulation	Reevaluate quality of discharge tailings. Change processing to lower levels of metals	Contract with KV/Plan of Operations	ADF&G/USFWS
Timber						
Compliance with timber sale contract provisions (sale administration)	On-site inspections	Before, during, and after harvest activities	In compliance with contract clauses or not	Get back into compliance	36 CFR Part 223	FS
Visual Quality						
Existing visual condition and visual quality objective	Documented with photos taken from established photo points	After construction, during operations, and after project completion	Determine if visual impacts meet anticipated VQOs	Recommend additional mitigation	FSH 2309.22	FS
Existing visual condition and visual quality objective	Documented with photos taken from established photo points	Once every 5 years for 15 years after reclamation	Determine if visual impacts meet anticipated VQOs	Photos will be used as reference in determining impacts and achieving VQO's in future planning	FSH 2309.22	FS
Geotechnical Stability						
Tailings structure construction materials	Visual inspection and gradation testing	As dictated by selected design needs	Per design documents	Remove non-conforming material	ADNR/Plan of Operations	KV/FS/ADNR
Tailings structure construction methods	Compaction and moisture tests along with other standard engineering practices	As dictated by selected design needs	Per design documents	Remove non-conforming material or apply additional effort to installation	ADNR/Plan of Operations	KV/FS/ADNR

Table 2-6, Kensington Monitoring Plan (cont'd)

Resource/Item to Measure	How	Frequency of Measurement	Threshold of Variability	Action to be Taken	Responsible Staff	Authority
Geotechnical Stability cont'd						
Tailings structure ongoing performance	Visual inspection, pore pressure measurement and measurement of vertical and horizontal movement	Quarterly for the first year, annually thereafter. After large earthquakes or other natural events	Per design documents	Per analysis of variance	ADNR/Plan of Operations	KV with FS/ADNR review
Waste rock pile stability	Visual inspection	Annual	Visible movement	As dictated by findings	Plan of Operations	KV with FS review
Stream diversion channel stability	Visual inspection	Annual	Significant wear, erosion, cracking or other findings	As dictated by findings	Plan of Operations	KV with FS review

Reclamation practices developed at other mining areas in the Pacific Northwest, including Alaska, are expected to work successfully for the Kensington Project. However, some revegetation experiments would be conducted during mining operations to determine optimum soil preparation, plant species, plant practices, and fertilizers for the range of soils and slopes present in disturbance areas. Field test plots would be established to determine the most appropriate revegetation practices.

The Kensington Venture has proposed to recontour and regrade the drained conventional tailings impoundment surface (Alternatives B, C, and D) to a natural undulating topography with a drainage channel restored across upper portions of the tailings. A center channel would be constructed to handle normal flows, and a flood plain channel for flood events or rapid snow melt runoff would be constructed. All channel banks would be stabilized as necessary. Riparian vegetation would be re-established.

Reclamation of the dewatered tailings disposal site (Alternative E) would be conducted on an on-going basis during operations. The face of the tailings pile would be stabilized and reclaimed during operations. At the completion of toe berm construction, revegetation would be initiated immediately. Proper drainage would be required to route surface water around the site. The disposal site would have a low permeable foundation to reduce seepage. Slopes would be reduced and drainage interception ditches would be built to prevent erosion. At closure, soil amendments would be placed over the tailings pile, which would then be revegetated.

Reclamation would occur through the life of this project. Construction reclamation would consist of development of drainage and erosion control facilities, recontouring, stabilization and revegetation of cut and fill slopes and other areas disturbed for construction. This phase of reclamation would be completed during project construction, which would last 22 months following project approval.

Reclamation would also occur during the operations phase, currently projected at 12 years. This would consist of reclaiming embankment slopes and other disturbed areas.

If the mine temporarily shuts down during production, interim reclamation would be required. Monitoring of the site would continue to occur to assure compliance with permit mitigation measures and provisions of 36 CFR Part 228.

Reclamation Planning

Final reclamation would be initiated at the time of mine closure. This final phase of reclamation would be expected to last up to 3 years.

The reclamation plan must contain the following:

- Final reclamation goals consistent with long-term land management objectives
- Mitigation requirements from the Record of Decision
- Mandatory information required by 36 CFR Part 228 regulations
- Reclamation criteria
  - Final configuration of the disturbed area
  - Mass stability requirements
  - Revegetation requirements
  - Reclamation requirements for interim shutdown
  - Air, water, and visual standards
  - Intervals for review of the operating plan and bond amounts
  - Conditions for bond release
- Bond calculations

The objectives of a reclamation program for the Kensington Project would be as follows:

- Protection of watershed and wetland values and functions
- Maintenance of water quality and beneficial uses
- Re-establishment of stable, self-sustaining stream channels
- Re-establishment of natural aquatic communities and resident fish habitat capabilities in stream channels above the tailings dam
- Establishment of interim ground cover to stabilize disturbed sites during operations
- Long term stabilization of tailings dam or dewatered tailings structures

- Re-establishment of diverse native vegetation communities for protection of watershed, riparian, fisheries, and wildlife values
- Re-establishment of viable, self sustaining wildlife and fish habitat
- Enhancement of aesthetic qualities of the area
- Protection of public health and safety by removing potential hazards
- Protection of recreational resources, and resource related activities, such as tourism and commercial fishing, found in the area
- Provision for long-term access to maintain critical drainage structures and monitor reclamation effectiveness

Reclamation Activities

These goals would be accomplished by completing the following specific activities. (*See Figure 2-22, Final Site Reclamation*).

- Decommissioning of facilities
- Removal of structures
- Portal closure and sealing
- Recontouring and regrading
- Cover material and soil replacement
- Soil sampling and fertilization
- Permanent revegetation
- Embankment erosion control and maintenance
- Reclamation management and monitoring

Each of these activities is described in the following sections.

Decommissioning of Facilities. Following permanent closure of the operation, all equipment, instrumentation, furniture, and/or unused reagents would be removed from the site or disposed of in a manner acceptable to the Forest Service. The various process equipment and piping in the mill would be flushed to remove or neutralize any reagents or chemicals prior to actual dismantling and removal.

Removal of Structures. All structures and facilities would be dismantled and removed from the site at the time of permanent operation closure. This includes the process complex, housing facilities, power generation and transmission facilities, shops, warehouses, fencing, powder magazines, and all other ancillary facilities. The marine port area,

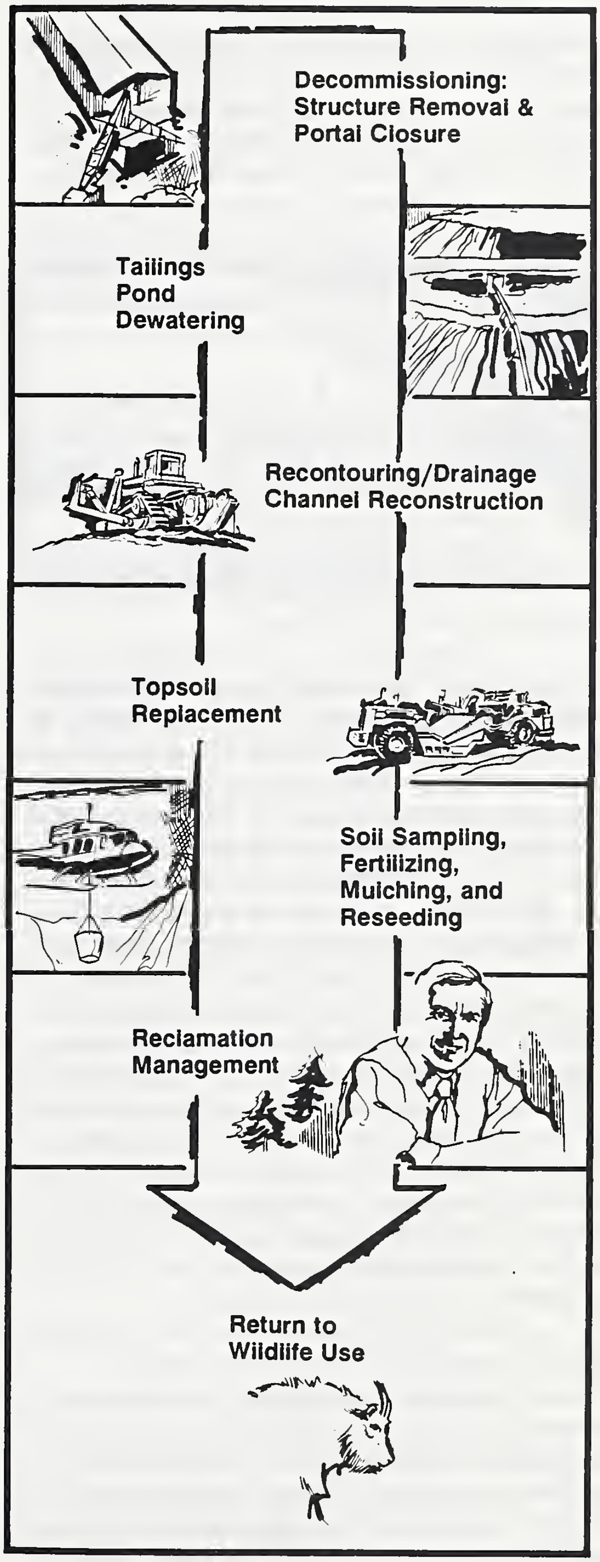


Figure 2-22, Final Site Reclamation

including the concrete planks and other docking facilities, also would be removed. All culverts and bridges would be removed during final reclamation.

Portal Closure and Sealing. At the completion of mining activities, all adits and ventilation raises to the surface would be permanently sealed by the placement of concrete and rock plugs. *(See Figure 2-23, Mine Adit Closure)*.

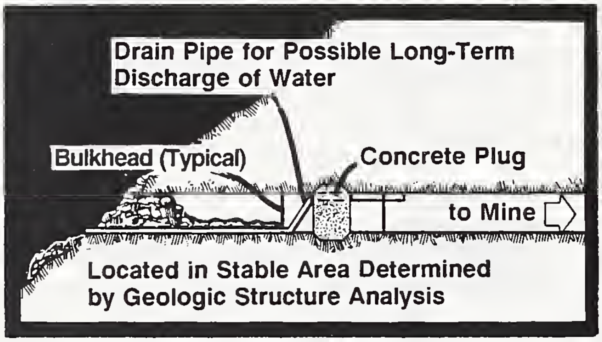


Figure 2-23, Mine Adit Closure

The abandoned mine workings could flood with water. Where appropriate, permanent sealing of the adits would be completed with a concrete plug or similar method so that any water released would be through an engineered outfall constructed as part of the adit closure activities. Rain or snowmelt infiltrating the subsoil above the mining area would be returned to flow patterns that existed prior to mining activities.

Recontouring and Regrading. The tailings material would be recontoured as appropriate. The main component of the recontouring and regrading activities would involve the restoration of an acceptable post-operational topography. During this phase of project closure, high traffic areas such as roads and helipads would be ripped to alleviate compaction. Post mining surface drainage patterns would be re-established to the extent practicable.

Cover Material and Soil Replacement. Following regrading activities, sites would be covered with soil or cover material as necessary. Soil resources are limited in the project area, however, some cover material might be available from mine development rock remaining on the surface. This rock material could provide a medium for root development and erosion control. This application would be evaluated by the pilot reclamation testing program conducted during the operating phase of the project.

Stockpiled cover material (available mineral soils) would be replaced as needed to serve as a rooting zone for revegetation. Soil amendments would be incorporated, as needed, to aid in vegetation rejuvenation.

All sites would be stabilized by means of regrading along the contour, reapplying cover material along the contour, and leaving the regraded surface in a roughened configuration to resist wind and water erosion. Surface manipulation treatments such as ripping and chiseling along the contour, contour furrows, pits and/or terraces would be constructed in areas that are likely to develop rills and gullies.

Soil Sampling and Fertilization. Surfaces to be revegetated would be sampled to characterize fertility status prior to seeding and planting. Major plant nutrients and trace elements would be quantified. In the event other amendments are necessary to promote plant establishment, they would be applied prior to revegetation, at levels recommended by the Forest Service.

Permanent Revegetation. Vegetation test plot studies would be developed during the operating life of the mine. These plots would be managed to identify optimum techniques for achieving short-term erosion control and final reclamation and project closure. Test plot studies would evaluate the preferred seed mixture(s), need for seed bed preparation, seed application rate(s), and whether mulch and fertilizers are necessary for achieving the reclamation goals of the project on various disturbance sites.

Reseeding on most areas would be conducted using broadcast application methods. The seed mixture to be used for permanent revegetation would be developed through the test plot program discussed above, published sources for reclamation work in southeast Alaska, and consultation with the Forest Service.

Reclaimed areas, such as the drained tailings impoundment, would be revegetated with

wetland or riparian species. Appropriate streambank deciduous and herbaceous vegetation (especially willow and alder) would be transplanted in the area, as practicable.

Mulching. If pilot testing indicates that erosion control materials would be required for initial stabilization, wood fiber mulch, straw, or erosion control/mulch blankets would be applied in a separate step following broadcast seeding. This would reduce initial erosion and sedimentation.

Reclamation Management and Monitoring. All newly reclaimed areas would be managed consistent with the reclamation goals. The sites would be examined periodically during the first several years after revegetation to determine the effectiveness of the reclamation program. The success of revegetation would be monitored to ensure erosion was prevented and that species re-establishment was occurring. Maintenance would be conducted on the site as necessary to ensure establishment of preferred species.

Interim Shutdown Measures

During operations, the Kensington Project may experience temporary shutdowns or periods when operations are curtailed. Cyclical production trends or slowdowns are unpredictable because they are due to a combination of circumstances including fluctuation in metal prices, labor costs, production costs, taxes, profitability of the company, and effects of national and international political and economic events.

Within a specified and mutually agreeable time frame, the Kensington Venture would notify the Forest Service of the temporary cessation of mining and milling activities. This notification would include reasons for the shutdown and an estimated time frame for resuming production.

During any temporary shutdown, operational and environmental maintenance activities would continue to ensure the site meets all permit stipulations and requirements for environmental protection. All environmental monitoring requirements would be maintained on defined schedules, as outlined in appropriate permit approvals. All environmental reports would be submitted in a timely manner. Regardless of the operating status of the project, appropriate monitoring would be continued until completion of project closure requirements.

Reclamation Guarantees

Forest Service regulations (36 CFR Section 228.13) require that an applicant submit a reclamation bond to ensure that adequate reclamation and restoration of the land is achieved following mining activities. A bond is a financial guarantee that would be forfeited to the Forest Service should the operator abandon the site. A bond would provide the Forest Service with sufficient funds to reclaim the site should the applicant fail to do so.

As part of the approval of the Plan of Operations, an appropriate reclamation financial surety must be filed with the Forest Service by the Kensington Venture.

ENVIRONMENTAL MEASURES NOT COMMON TO ALL ALTERNATIVES

Certain mitigation and environmental management considerations are not common to all action alternatives being considered in the Kensington Gold Project EIS. If the No Action Alternative is selected, it is likely that no additional exploration would occur at the project site, as there would be no economic incentive to the Applicant to continue exploration, baseline and operational monitoring, or any other mining-related activities. The Kensington Venture would be expected to cease all activities except caretaking at the site. After the mandatory prescribed time frame, the Kensington Venture would implement reclamation/closure activities according to the Plan of Operations approved for exploration.

Mitigation and management constraints not common to all the action alternatives are described in the following sections.

Alternative B - Environmental Constraints

Geotechnical Monitoring. A dam safety approval from ADNR and the Forest Service would be required. During operations, daily visual observations would be made of the tailings disposal facilities to check the condition of the embankment, impoundment, pipelines, and water control facilities. Significant

observations would be recorded in a field diary. Special attention would be given to any scour erosion, vegetation growth, blocked spillways, plugged pipelines or drains, and ongoing operation of instrumentation.

A series of wells would be established in the impoundment structure to measure the pore pressure. These wells would be located in the downstream face of the embankment as well as the up stream face above the cut-off wall.

In addition to the wells, instrumentation (piezometers, settlement gauges, etc.) would be installed on the crest and external slope of the structure to monitor the stability of the impoundment. This instrumentation would be checked regularly and recordings made in a field diary. Visual and instrumentational monitoring would be conducted by operating personnel. A record of all such data would be maintained onsite. These measures would also be incorporated into Alternative C, D, and F.

Tailings Pond Dewatering. Water in the tailings impoundment would have to be eliminated at the time of permanent plant decommissioning, prior to recontouring and revegetation. Water could be disposed in one or a combination of the following ways:

- Marine discharge of treated effluent (any such discharge would be subject to NPDES requirements)
- Evaporation through aerial spraying on tailings beach areas
- Land application at an adjacent designated and approved site

The quality of the water left in the tailings impoundment would be sampled and analyzed to ensure that no environmental degradation would occur as a result of its discharge or land application. Any discharge or land application of this excess water in the impoundment would be based on approval by the EPA and ADEC. These measures would also be incorporated into Alternative C, D, and F.

Employee Camp. Helicopter transportation of employees would be conducted to minimize disturbance on wildlife, especially mountain goat. The flight path of the helicopter would avoid routes that disturbs species such as mountain goats and bald eagles.

The Kensington Venture has agreed to implement a no guns and no trapping policy for anyone working and living onsite thus eliminating increased hunting and trapping pressure by project personnel. Workers living in the employee camp would be required to adhere to company fish and wildlife management policies. These measures would also be incorporated into Alternatives D, E, and F.

Lynn Canal Access. Lynn Canal is used by commercial fishermen, barge traffic, cruise ships, and sport fishermen. Discussions would be continued among the various users of Lynn Canal in order to bring about cooperative management and communication regarding marine traffic. Scheduling of barge traffic to Kensington around fishing openings, to the extent practicable, would minimize conflicts with commercial fishing. This measure would also be applied to Alternatives D, E, and F.

Alternative C - Environmental Constraints

Transport across Berners Bay must be conducted in a way to minimize impact to recreational users within Berners Bay, including kayakers and airboaters. This would mean avoidance of kayakers, airboaters, and other water recreationalists in Berners Bay. Facilities within the Slate Creek Cove area of Berners Bay would be designed and constructed to minimize impacts to visual resources in the area. Existing stands of trees would be preserved to provide screening and lessening of visual contrasts presented by Slate Creek Cove facilities.

If project employees are housed in Juneau and transported on a daily basis to the project site, a docking site would be needed somewhere within Auke Bay. If such a terminal area has limited parking, then a bus service for workers to and from the ferry terminal from different locations in Juneau would be required.

Measures described under *Alternative B - Mitigation Measures* for geotechnical monitoring, hydrologic monitoring, and tailings pond dewatering would be included in this alternative.

Alternative D - Environmental Constraints

The tailings slurry line would be placed on the uphill side of the access road from the process area to the tailings pond. It would be a double wall pipeline system that would provide protection against tailings leaks and associated spillage.

Measures described under *Alternative B - Mitigation Measures* for geotechnical monitoring, hydrologic monitoring, tailings pond dewatering, and employee camp would be included in this alternative.

Alternative E - Environmental Constraints

Under this alternative interceptor ditches would be constructed around the dewatered tailings structure to collect runoff from the semi-pervious surface. This runoff would then be routed to a polishing pond for treatment prior to any discharge. The ditches would also receive drainage from the french drain rock areas. This drainage would be treated in accordance with the NPDES requirement for point source discharges.

Wind erosion from the dewatered tailings disposal would be controlled by water during operation.

A separate storage shelter of 50,000 square feet would be required to store 40,000 tons of dewatered tailings during inclement weather. This would allow placement of the tailings during dry periods improving trafficability and overall tailings stability during the life of the project.

The employee camp and Lynn Canal access mitigation described under *Alternative B - Mitigation Measures* would be included in this alternative.

Alternative F - Environmental Constraints

The only differences between this alternative and the applicant proposal is the location of the marine outfall and additional water treatment. As such all of the environmental constraints outlined under Alternative B would be applied to this alternative as well.

IDENTIFICATION OF THE PREFERRED ALTERNATIVE

The Forest Service will identify the Preferred Alternative in the Record of Decision.

COMPARISON OF ALTERNATIVES

The alternatives for the Kensington Gold Project have been developed and evaluated based on the issues identified as part of the public scoping process. *Table 2-7, Action Alternatives Compared*, shows differences between project alternatives. The Forest Service reviewed all issues for significance. Significant issues were used to compare effects of project alternatives. *Table 2-8, Comparison of Impacts*, shows which issues were determined to be significant and would serve as a basis for comparing impacts of the project alternatives. This table shows the relative impacts of each alternative, including the No Action Alternative, to the significant issues.

Table 2-7, Action Alternatives Compared

	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F		
					Option 1	Option 2	Option 3
Waste Rock	Consumed in roads and tailings dam	Consumed in roads and tailings dam	Permanent waste rock near lower portal	Consumed in roads and tailings buttress	Consumed in roads and tailings dam		
Crushing	Located underground	Located underground	Located underground	Located underground	Located underground		
Grinding	Located on surface	Located on surface	Located underground	Located on surface	Located on surface		
Tailings Disposal	Cross valley dam (crest 270 ft. high by 2,400 ft. long) in Sherman Creek	Cross Valley dam (crest 270 ft. high by 2,400 ft. long) in Sherman Creek	Cross valley dam (crest 370 ft. high by 1,400 ft. long) in Sweeny Creek	Dry disposal in one of two locations (site A - 340 ft. tall; Site B - 280 ft. tall)	Cross valley dam (crest 270 ft. high by 2,400 ft. long) in Sherman Creek		
Employee Transportation	Helicopter from Juneau airport	Ferry to Slate Creek Cove	Helicopter from Yankee/Bridget Cove	Helicopter from Juneau airport	Helicopter from Juneau Airport		
Supply Transportation	Tug/barge to Comet Beach	Tug/Barge to Slate Creek Cove	Tug/barge to Comet Beach	Tug/barge to Comet Beach	Tug/barge to Comet Beach		
Power Supply	Two LPG fired generators at facilities	Two LPG fired generators at facilities	Two LPG fired generators near beach	Three LPG fired generators at facilities	Two LPG fired generators at facilities		
Employee Housing	Onsite camp	Onsite camp for emergency only	Onsite camp	Onsite camp	Onsite camp		
Rock Quarry/Borrow	Near taiiings dam	Within tailings area and along road to Slate Creek Cove	Near tailings dam	Near facilities in Sherman Creek basin	Within tailings area		
Site Roads	2.2 miles	9 miles	3.2 miles	3 miles (Site A) 2.2 miles (Site B)	2.2 miles		
Effluent Pipeline	1 mile	1 mile	1.2 miles	0.4 mile (Site A) 0.1 mile (Site B)	1.8 miles		
Tailings Pipeline	Negligible	Negligible	2 miles	N/A	negligible		
LPG Pipeline	1.8 miles	9 miles	0.4 miles	1.8 miles	1.8 miles		

Table 2-7, Action Alternatives Compared (cont'd)

	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F		
					Option 1	Option 2	Option 3
Stream Diversions	Ophir (2,000 ft.) and Sherman (6,000 ft.) diverted, concrete return channel	Ophir (2,000 ft.) and Sherman (6,000 ft.) diverted, riprap return channel	Sweeny (6,000 ft.) diverted, riprap return channel	No diversion	Ophir (2,000 ft.) and Sherman (6,000 ft.) diverted, concrete return channel		
Cyanide Destruction	Alkaline Chlorination	Alkaline Chlorination/ Dechlorination	Alkaline Chlorination/ Dechlorination	Hydrogen Peroxide	Alkaline Chlorination/ Dechlorination	Alkaline Chlorination/ Dechlorination	Hydrogen Peroxide
Metals and Solids Treatment	Pond Settling	Enhanced Pond Settling	Enhanced Pond Settling	Enhanced Pond Settling	Enhanced Pond Settling	Enhanced Pond Settling & Effluent Filtration	Enhanced Pond Settling, Chemical Precipitation and Settling of Leach Circuit Tails
Water Discharge	N. of Pt. Sherman	N. of Pt. Sherman	N. of Pt. Sherman	N. of Pt. Sherman	S. of Pt. Sherman		
Total Disturbance	275 acres	392 acres	229 acres	237 acres	277 acres		

Table 2-8, Comparison of Impacts

Alternative	Discussion and Comments
Socioeconomics (Addresses impacts on Juneau, Haines, and Skagway.)	
Alternative A - No Action	The opportunity for a maximum gain of 380 jobs associated with project development would not occur.
Alternative B - Applicant Proposal	Employment projections estimate annual employment of 360 persons (450 max. during 2-year construction period). Revenues and taxes will offset "direct" impacts. Maximum housing demand for over 800 units in Juneau.
Alternative C - Berners Bay Access	Restricts mine employees to Juneau residence.
Alternative D - Sweeny Creek Tailings	Impacts for this alternative are, for all practical purposes, the same as described for Alternative B.
Alternative E - Dry Tailings	Impacts for this alternative are, for all practical purposes, the same as described for Alternative B.
Alternative F - Southern Marine Discharge	Impacts for this alternative are, for all practical purposes, the same as described for Alternative B.
Fisheries (Maintain quality of existing fish habitat and minimize impacts to commercial fishery in Lynn Canal.)	
Alternative A - No Action	The existing status of all the major stream fisheries in the project area would remain essentially status quo. Stream flows could be reduced if the existing adit is plugged, according to the closure pan. No significant habitat loss would be expected in the Sherman Creek drainage.
Alternative B - Applicant Proposal	Marine - Analysis shows that levels of cyanide and heavy metals in effluent discharge can meet water quality standards at the edge of the mixing zone. No impacts to fisheries are expected. Sediment accumulation is expected in the vicinity of the outfall. Some heavy metal accumulation may occur only in sedentary, bottom-dwelling organisms (e.g., tubificid worms and polychaetes) near the outfall. There is a potential for physical interference between the outfall pipeline and anchoring of fishing boats. Freshwater - Approximately 6,000 feet of Sherman Creek and 2,000 feet of Ophir Creek would be diverted. No direct loss of anadromous fisheries habitat would occur due to the existing natural barrier 1,000 feet above the mouth of Sherman Creek. Construction of the tailings impoundment and diversions would initially increase sediment loads along a 1,000-foot downstream portion of pink salmon spawning habitat in Sherman Creek. Small populations of Dolly Varden char and sculpin would be lost from the diverted section of Sherman Creek. Fisheries and habitat quality were rated lower for Sherman Creek than for Sweeny Creek.
Alternative C - Berners Bay Access	Marine - Potential fisheries impacts related to effluent discharge would be the same as for Alternative B. Freshwater - Potential impacts related to tailings disposal would be the same as for Alternative B.
Alternative D - Sweeny Creek Tailings	Marine - Potential fisheries impacts related to effluent discharge would be the same as for Alternative B. Freshwater - Approximately 6,000 feet of Sweeny Creek would be diverted. No direct loss of anadromous fisheries habitat is expected with this alternative, but construction of the tailings impoundment and diversions would initially increase sediment loads along at least a 2,600-foot downstream portion of pink salmon spawning habitat in Sweeny Creek. In addition, construction of the facilities area would increase sediment loads in Sherman Creek. Populations of Dolly Varden char, cutthroat throat, and sculpin would be lost from the diverted section of Sweeny Creek. Fisheries and habitat capability were rated higher for Sweeny Creek than for Sherman Creek.

Table 2-8, Comparison of Impacts (cont'd)

Alternative	Discussion and Comments
Fisheries cont'd	
Alternative E - Dry Tailings	Marine - Potential fisheries impacts related to effluent discharge would be essentially the same as Alternative B. Freshwater - No direct loss of stream habitat would occur with either tailings structure location alternative. Increased sediment loads in downstream portions of Sherman Creek would occur with construction and operation of tailings Site A, while increased sediment loads in downstream portions of Sweeny Creek could occur with tailings Site B. Windblown tailings have the potential to increase sediment loads in Sherman or Sweeny creeks, depending on the tailings site and wind direction, throughout project operation.
Alternative F - Southern Marine Discharge	Marine - Potential fisheries impacts related to effluent discharge would be the same as Alternative B except that total heavy metal and sediment loads released into Lynn Canal would be reduced. The location of the outfall south of Point Sherman would reduce the risk of physical interference between the outfall pipe and anchoring of fishing boats. Freshwater - Potential fisheries impacts related to tailings disposal would be the same as Alternative B.
Marine Transportation (Minimize disruption to Lynn Canal marine traffic.)	
Alternative A - No Action	Point Sherman is important to commercial salmon fishing in Lynn Canal. This alternative would present essentially no conflict with the gillnet industry. Once reclamation and closure were completed, the impacts to the commercial fishery would be negligible.
Alternative B - Applicant Proposal	Materials, equipment, and fuel would be transported to the Comet Beach marine terminal facility during construction and operation of the project. This would involve a limited increase in overall Lynn Canal summer traffic (due to heavy summer use by other traffic), and a 25 percent increase in winter use. Transportation mitigation opportunities include the ongoing MOA negotiations with the S.E. Alaska Gillnetters and the overall Lynn Canal transportation planning effort now underway.
Alternative C - Berners Bay Access	Transportation impacts to Lynn Canal would be insignificant, since the Comet Site would not be used for materials transport. Increases in Berners Bay marine traffic would be expected due to the daily commute requirement.
Alternative D - Sweeny Creek Tailings	Impacts for this alternative would be the same as described for Alternative B.
Alternative E - Dry Tailings	Impacts for this alternative would be the same as described for Alternative B.
Alternative F - Southern Marine Discharge	Impacts for this alternative would be the same as described for Alternative B except that potential anchor fouling N. of Pt. Sherman is reduced.
Water Quality (Maintain watershed integrity and related water quality.)	
Alternative A - No Action	Certain ground water resource impacts related to increased discharge from the mine area occurred due to underground exploration. Flows ranging from 200 to 400 gpm currently exist. With planned closure and reclamation, the discharge would decrease, possibly affecting surface flows during normal low flow season.
Alternative B - Applicant Proposal	Water discharged from the mine adit would be used in the processing of ore from the mine. At closure, water quality conditions related to mine drainage and tailings disposal should not change from those described above. For surface water, sediment loads in Sherman Creek would occur during construction. Impacts related to accidental spills could occur in association with fuel transfer and hazardous chemicals off-loading at Comet Beach.

Table 2-8, Comparison of Impacts (cont'd)

Alternative	Discussion and Comments
Water Quality cont'd	
Alternative C - Berners Bay Access	Potential impacts to ground water are similar to those described for Alternative B. For surface water, transportation requirements involving the 8.5 mile access road would increase the risk of accidental spills. Sediment load impacts to Sherman Creek would be the same as in Alternative B. Berners Bay recreational users would face potential water quality impacts associated with accidental spills during fuel transfer and hazardous chemicals off-loading.
Alternative D - Sweeny Creek Tailings	Potential impacts to ground water are similar to those described for Alternative B. For surface water, increased sediment loads would occur within two drainages (Sherman and Sweeny) during construction. Slurry pipeline requirements would increase the hazard of accidental spill situations (approximately 2 miles of tailings pipeline).
Alternative E - Dry Tailings	Potential impacts to ground water are similar to those described for Alternative B. For surface water, construction would increase sediment loads in Sherman Creek with Site A, while increased sediment loads would occur in Sweeny Creek with Site B. Windblown tailings have the potential to increase sediment loads in Sherman or Sweeny creeks, depending on site selection and wind direction, throughout project operation.
Alternative F - Southern Marine Discharge	Potential impacts to ground and surface water are the same as Alternative B.
Recreation (Minimize impacts to recreational opportunities.)	
Alternative A - No Action	No major effects are anticipated because mining-related use of the overall study area would be minimized by this alternative.
Alternative B - Applicant Proposal	Very little recreation use would be impacted if proposed mitigation measures are implemented by the Applicant.
Alternative C - Berners Bay Access	All impacts associated with Alternative B would apply. Recreational activities in Berners Bay would be adversely affected by increased traffic and mining-related activities.
Alternative D - Sweeny Creek Tailings	Similar to effects described for Alternative B.
Alternative E - Dry Tailings Disposal	Similar to effects described for Alternative B.
Alternative F - Southern Marine Discharge	Similar to effects described for Alternative B.
Air Quality and Visibility (Minimize visual impacts on Lynn Canal and Berners Bay.)	
Alternative A - No Action	Visual impacts for this alternative would be the same as those for the existing exploration project, until full reclamation and closure is completed.
Alternative B - Applicant Proposal	The primary visual impact would involve the Sherman Creek tailings dam (270 ft. high by 2,400 ft. long). Air quality impacts were calculated to be well below allowable Federal and Alaska ambient air quality standards.
Alternative C - Berners Bay Access	Visual impacts are the same as described for Alternative B, with the exception of the marine terminal at Slate Creek Cove and the 8.5 mile access road. Additional visibility impacts could result from the access road running parallel to Lynn Canal. Pollutant emission rates would be similar to those projected for Alternative B, except for TSP. Total annual TSP emission rates would be nearly double that for Alternative B because of the longer travel distances required for the Berners Bay access road. No violation of ambient air quality standards would be expected.

Table 2-8, Comparison of Impacts (cont'd)

Alternative	Discussion and Comments
Air Quality and Visibility cont'd	
Alternative D - Sweeny Creek Tailings	Tailings dam (370 ft. by 1,400 ft.), due to location, is less visible from Lynn canal than the Alternative B tailings dam. Pollutant emission rates would be similar to those projected for Alternative B, except TSP emissions would be slightly greater. No violation of ambient air quality standards would be expected.
Alternative E - Dry Tailings	This tailings option would expose a 280-ft. to 340-ft. high upland embankment, as compared to the valley embankments for Alternatives B, C, and F. Pollutant emission rates would be similar to those projected for Alternative B, except for TSP. Total annual TSP emission rates would be nearly six times that for Alternative B, primarily because of the continuous operation of the dry tailings structure and windblown emissions from this facility. Particulate emissions in excess of ambient air quality standards could occur outside the public access boundaries with this alternative. Water spray or other mitigation may need to be employed during dry periods to prevent violation of standards. A steam plume from tailings drying would be visible during periods of mine operation.
Alternative F - Southern Marine Discharge	Visual and air quality impacts would be the same as Alternative B.
Land Use/Reclamation (Minimize land area disturbance.)	
Alternative A - No Action (LU)	The No Action Alternative would not significantly affect land use in the study area.
Alternative B - through F (LU)	The acreages to be disturbed would not be significant in terms of meeting the land use objective.
Alternative A - No Action (Reclamation)	Reclamation and closure would involve minimal activities including portal plugging and revegetation.
Alternative B - Applicant Proposal	Key reclamation involves channel reconstruction and long term maintenance through the tailings pile, associated revegetation and decommissioning. The alternative would affect about 275 acres.
Alternative C - Berners Bay Access	This alternative would impact several drainages, and cross significant wetlands. Reclamation would require rehabilitation/revegetation of an additional 8.5 miles of access road. The Slate Creek Cove marine terminal is located in a sensitive land use/recreation area. The alternative would affect over 392 acres of land area.
Alternative D - Sweeny Creek Tailings	This alternative would effect two drainages. Total impacted acreage involves about 229 acres. Reclamation of the tailings dam is rated more difficult than Alternative B primarily due to the steepness and height of the tailings embankment and associated stream diversion requirements.
Alternative E - Dry Tailings	This alternative would not directly impact any stream channels. Total impacted acreage involves 237 to 242 acres, depending on disposal location. Reclamation of tailings pile performed concurrent with construction. Stability problems related to placing and compacting dewatered tailings in a moist climate could result in short-term and long-term stabilization and reclamation problems. The potential for reestablishment of wetlands on the tailings structure would be the lowest with this alternative.
Alternative F - Southern Marine Discharge	This alternative would have the same effects and objectives as Alternative B.
Wildlife (Minimize wildlife impacts.)	
Alternative A - No Action	This alternative would minimize additional impacts to wildlife habitat and populations.

Table 2-8, Comparison of Impacts (cont'd)

Alternative	Discussion and Comments
Wildlife cont'd	
Alternative B - Applicant Proposal	This alternative would impact about 275 acres of habitat, of which 232.8 acres are wetlands. The relative importance value calculated for wetlands (in relation to their importance to wildlife habitat, water quality, ground water recharge, sediment control, etc.) lost to this alternative is 4,759. Reductions in black bear and mountain goat habitat capability would occur with this alternative. No significant impacts to marine mammals or waterbirds are projected for this alternative. Model projections of noise impacts indicate some impairment of mountain goat and black bear habitat and population loss. No significant impacts would occur to marine wildlife with the construction of the excavated marine terminal.
Alternative C - Berners Bay Access	This alternative impacts the greatest amount of habitat (392 acres), of which 335.9 acres are wetlands. This alternative affects the largest amount of wetlands because of additional disturbances associated with the Berners Bay access road. The relative importance value calculated for wetlands lost (6,387) is the largest for this alternative. Reductions in mountain goat and black bear habitat capability would be similar to Alternative B. The greatest number of bald eagle nest sites could be affected by this alternative. A marine docking facility in Slate Creek Cove would have the greatest potential to impact waterbirds due to its proximity to estuarine habitats.
Alternative D - Sweeny Creek Tailings	This alternative would create the least amount of habitat disturbance, 229 acres, but would impact habitats in two drainages. The smallest amount of wetlands (123.5 acres) would be impacted with this alternative. In addition, the relative importance value calculated for wetlands lost (2,735) is the lowest for this alternative. Reductions in mountain goat and black bear habitat capability would be lowest with this alternative. Other impacts would be similar to Alternative B.
Alternative E - Dry Tailings	Total habitat disturbance with Site A and Site B (242 and 237 acres, respectively) would be somewhat less than Alternative B but greater than Alternative D. The total amount of wetland acreage lost to Alternative E also falls between Alternative A and D. The relative importance value calculated for wetlands lost with Site A and Site B would be 3,549 and 4,568, respectively. Reductions in mountain goat and black bear habitat capability would be higher with Site A than with any other alternative.
Alternative F - Southern Marine Discharge	Impacts would be the same as described for Alternative B.
Subsistence (Identify subsistence resources and level of use.)	
Alternative A - No Action	Subsistence would remain status quo with this Alternative.
Alterative B - Applicant Proposal	No subsistence communities have been documented in the project area.
Alternative C - Berners Bay Access	The Berners Bay area holds the most potential for subsistence use. More distant communities such as Klukwan, Haines, and Skagway use marine sources. However, these communities are significantly north of the Kensington Gold Project.
Alternative D - Sweeny Creek Tailings	Same as described for Alternative B.
Alternative E - Dry Tailings	Same as described for Alternative B.
Alternative F - Southern Marine Discharge	Same as described for Alternative B.
Cumulative Impacts (Address the potential for other development and cumulative impacts.)	
Alternative A - No Action	This alternative would result in no cumulative impacts (status quo).

Table 2-8, Comparison of Impacts (cont'd)

Alternative	Discussion and Comments
Cumulative Impacts cont'd	
Alternative B - Applicant Proposal	This alternative would result in cumulative impacts to the study area for all major impact categories and/or issues if the Jualin and AJ projects were developed. Impacts such as increased hunting and fishing pressure in the region, loss of wildlife habitat, additional recreational use of region, and increased need for public services would result.
Alternative C - Berners Bay Access	Same as described for Alternative B.
Alterative D - Sweeny Creek Tailings	Same as described for Alternatives B.
Alternative E - Dry Tailings	Same as described for Alternatives B.
Alternative F - Southern Marine Discharge	Same as described for Alternatives B.
Technical Feasibility (Incorporate technical feasibility into design and mitigation.)	
Alternative A - No Action	Kensington exploration site would be reclaimed under existing Plan of Operations.
Alternative B - Applicant Proposal	This alternative is contained in a single drainage, and would combine a sound mining and processing plan with appropriate management constraints and mitigation. Tailings embankment would be constructed using a modified centerline technique and would be designed to withstand the maximum probable seismic event for this region. Final post mining drainage designs would need to be conservative to address concerns about potential erosion and long term stability. Ongoing monitoring has been designed to measure operational impacts and closure objectives.
Alternative C - Berners Bay Access	Similar to Alternative B except the feasibility of this alternative is limited primarily by maximum areal disturbance (392 acres), access requirements (8.5 miles of new road), and disturbance of additional major drainages and wetlands.
Alternative D - Sweeny Creek Tailings	Similar to Alternative B.
Alternative E - Dry Tailings	This alternative would not require diversion of any stream channels. Extensive operational control procedures would be required during placement of the dry tailings due to the moisture sensitivity which affects stability. A key concern is that moisture content of the tailings must not exceed 14% during placement in order for the pile to resist liquefaction or mass movement under extreme earthquake loading. This method is currently being employed successfully on a much smaller scale at Greens Creek, but there is no first hand experience available for an operation the scale of the Kensington Project in a region with high precipitation.
Alternative F - Southern Marine Discharge	This alternative is similar to Alternative B but with additional water treatment using proven technology.
Economic Feasibility (Develop cost-effective project.)	
Alternative A - No Action	This alternative would result in a direct investment loss of over $200 million to the Kensington Venture.
Alternative B - Applicant Proposal	Construction costs for this alternative are estimated at $166.8 million with an annual operating budget of $41.7 million. The CBJ would realize fiscal deficits in early project years. A surplus would be achieved later in project life.
Alternative C - Berners Bay Access	This alternative involves slightly higher capital ($1.0 million) and annual ($1.5 million) operating costs.

Table 2-8, Comparison of Impacts (cont'd)

Alternative	Discussion and Comments
Economic Feasibility cont'd	
Alternative D - Sweeny Creek Tailings	Similar to Alternative B.
Alternative E - Dry Tailings	Similar to Alternative B. Capital costs are estimated to be $1.8 to $2.2 million lower while operating costs are estimated at $3.3 to $3.8 million higher than Alternative B (annual).
Alternative F - Southern marine Discharge	Similar to Alternative B.

CHAPTER THREE
AFFECTED ENVIRONMENT

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3-26 Black Bear Yearlong Habitat Capability 3-55

INTRODUCTION

This chapter discusses the existing environmental resources in the study area which may be affected by implementation of an action alternative. The extent of the area analyzed and discussed in this document varies with the resource addressed. For certain resources such as wetlands and cultural resources, the study area was considered to be the area of potential direct disturbance. For other resources, such as wildlife, visual, and socioeconomics, a broader study area was utilized to encompass the potential off-site aspects of issues related to these resource categories. For clarification purposes, the following definitions apply throughout this document.

Project Area: The specific area within which all surface disturbance and development activities would occur.

Study Area: A larger peripheral zone around the project area within which most potential direct and indirect effects to a specific resource would be expected to occur.

Baseline study reports completed by contractors to the Kensington Venture have been reviewed by the Forest Service and ACZ ID teams. The ID teams evaluated these and other sources of existing information, determined additional information needs, and collected additional data. All final work products and analyses prepared by Kensington contractors or ID team members and used for the preparation of this EIS are contained within the Forest Service Planning Record (Juneau District Office, Tongass National Forest). The Planning Record is a detailed, formal account of the planning process used to document the decision making process required for the preparation of an EIS and subsequent decision documents.

Since many of the documents and analyses used in the preparation of this FEIS are lengthy and technical in detail, the results are often only summarized or referenced in this FEIS as required by CEQ regulations. CEQ regulations at 40 CFR 1502.15 require that an EIS "succinctly describe the environment of the area(s) to be affected or created by the alternatives under consideration." They further require that the "data and analyses be commensurate with the importance of the impact, with less important material summarized, consolidated, or simply referenced."

AIR QUALITY AND CLIMATE

Although no measurements of air pollution have been made onsite, the air quality in the vicinity of the Kensington Project site is expected to be very good. The nearest air pollution sources are those at Haines, 25 miles distant. The absence of nearby air pollution sources, coupled with abundant rainfall and frequent winds, suggest that existing background pollutant concentrations would be small. Existing background concentrations of air pollutants have been assumed to characterize the airshed near the Kensington Project (TRC, 1991). (*See Table 3-1, Background Pollutant Concentrations*). All background pollutant

Table 3-1, Background Pollutant Concentrations

Pollutant	Time Interval	Concentration ($\mu g/m^3$)[1]	Comment
Nitrogen Oxides	Annual	4	Arithmetic mean
Sulfur Dioxide	3-Hour	---	Below detectable level
	24-Hour	---	Below detectable level
	Annual	---	Below detectable level
Particulates	Annual	22	Geometric Mean
	24-Hour	40	Maximum 24-Hour

[1]Micrograms/cubic meter

concentrations are below Alaska and Federal Ambient Air Quality Standards.

Meteorological data were collected at the Kensington Project site from February 1989 through February 1990 (TRC, 1991). Instrumentation (wind speed, wind direction, and temperature) was mounted on a 10-meter tower in a forest clearing near the proposed location of the Kensington facilities. The long-term pattern of wind directions is shown on *Figure 3-1, Wind Direction Frequency*, which

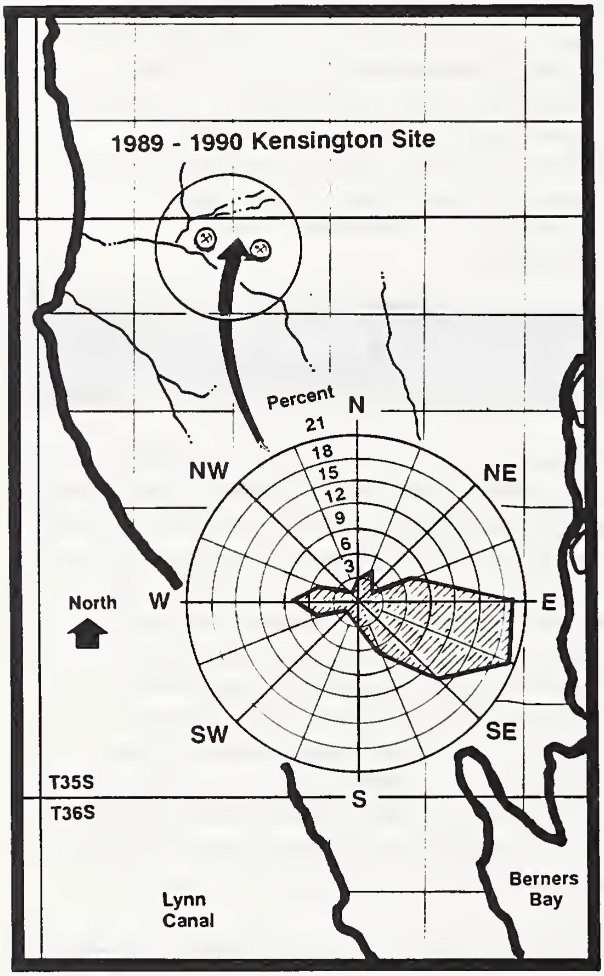


Figure 3-1, Wind Direction Frequency

presents the frequency of occurrence of directions from which the wind blows. Winds come predominately from the east and east-southeast directions, in line with the Sherman Creek canyon axis. Cross canyon wind directions are rare because the terrain "funnels" airflow (TRC, 1991).

The average wind speed at the site is low, only 3.7 miles per hour, and high wind episodes are very unusual. (*See Table 3-2, Wind Speed and Stability Class Distributions*). The low wind

Table 3-2, Wind Speed and Stability Class Distributions

Wind Speed (knots)	Frequency (percent)
0 - 3	70.98
4 - 6	19.91
7 - 10	7.63
11 - 16	1.46
17 - 21	0.02
Greater than 21	0.00
Stability Class	**Frequency (percent)**
A	0.57
B	0.26
C	3.27
D	55.32
E	21.01
F	19.57

speeds are caused, in part, by the sheltering effect of trees.

The temperatures at the Kensington Project site are reasonably uniform, with no large daily variations. Temperatures are similar to those in Juneau (TRC, 1991). The maritime climate is influenced by currents in the Pacific Ocean which prevent temperature extremes from being common place.

The Eldred Rock weather station has operated over a long period of time (1941, 1943 to 1973) and is the closest certified weather station to the Kensington Project site (approximately 7.5 miles north). The average annual temperature for the Eldred Rock weather station is 41.4 degrees F. The minimum temperature recorded is minus 20 degrees F. Winter temperatures generally range from lows of 20 to 30 degrees F to highs near 30 degrees F. Summer mean high temperatures are near 60 degrees F, while the mean lows are around 55 degrees F.

Rainfall is heavy and frequent at the Kensington Project site. Precipitation occurs at least 180

days per year. Based on climatic data from the Eldred Rock weather station, the average annual precipitation for the project region is 47.87 inches. The elevation of the Eldred Rock weather station is 60 feet MSL. Average annual rainfall at the Kensington Project site is estimated to be 80 inches due to the influence of elevation and terrain (USDA, 1979).

The wettest month of the year is October, which receives an average monthly rainfall of 9.05 inches. The driest month is April, which receives an average of 2.14 inches. Annually there are 28.9 days per year for which precipitation amounts exceed 0.5 inch, 52.3 days that receive more than 0.25 inch, and 106.0 days that rainfall exceeds 0.1 inch. There are approximately 48.1 days that receive 1.0 inch of snow per year.

The potential for dispersion of airborne pollutants at the Kensington Project site is determined by the stability class, or measure of atmospheric turbulence. Stability classes are divided into six categories, designated "A" through "F". The greatest pollutant dispersion occurs during stability class "A" and the least occurs during class "F". The onsite distribution of stability classes (TRC, 1991) is similar to that found in all of Southeast Alaska. *(See Table 3-2, Wind Speed and Stability Class Distributions)* Stability class "A" occurs infrequently due to the lack of strong solar insolation. Stability class "D" occurs most frequently (55 percent of the time) at the project site. The moderately high frequency of stable atmospheres ("E" and "F" classes occur 40 percent of the time) for the area indicates that there is a potential for elevated air pollution onsite due to temperature inversion conditions.

Atmospheric clarity is measured by visual range, the average distance at which contrasting objects can be discriminated. The background visual range at the Kensington Project site is small, only 40 kilometers (EPA, 1988). The small visual range is caused by clouds and water vapor which frequently obscure the sight of distant objects.

TOPOGRAPHY

The Kensington Project is located within the Berners Bay mining district. The proposed Kensington site is within the Sherman Creek drainage at the western foot of Lions Head Mountain in the Kakuhan Range of the coastal mountains. The Kakuhan Range is a north-northwest trending mountain range composed almost entirely of massive cliff forming rocks. Lions Head mountain has an elevation of approximately 5,000 feet above sea level. Drainages in the area are quite steep and are characterized by smooth, frequently dissected, shallowly incised mountain slopes with gradients steeper than 75 percent. The topography of the peninsula to the south and west of Lions Head Mountain consists of relatively subdued hills with parallel drainages following regional geologic strike. *(See Figure 3-2, Topography)*.

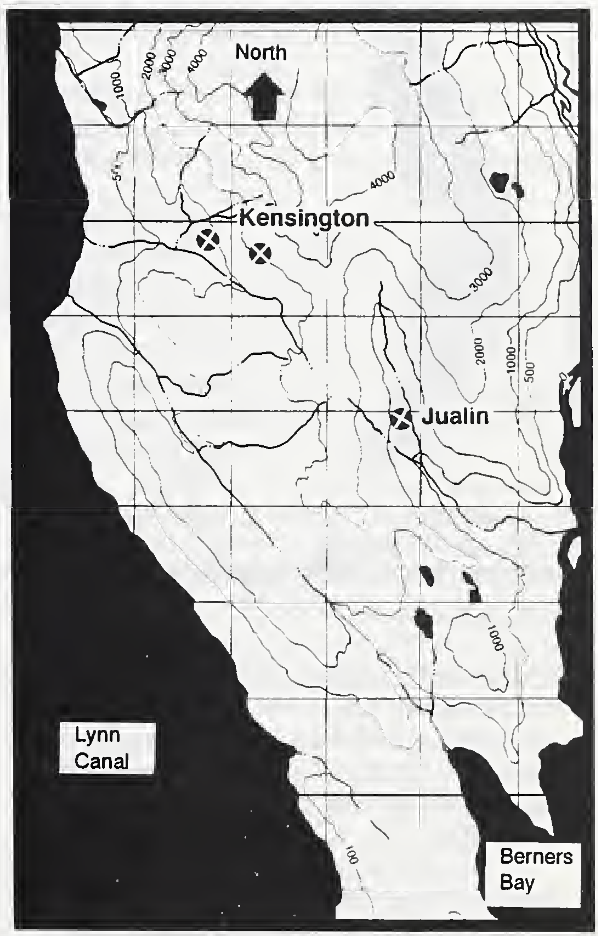


Figure 3-2, Topography

GEOLOGY

The ore deposit at the Kensington Project site is found in the north end of the Juneau Gold Belt. (*See Figure 3-3, Geology*). The Kensington vein system trends roughly north-south, but the strike varies locally by up to 20 percent. The zone dips steeply, 60 to 70 degrees to the east. The ore body consists of a collection of narrow, discontinuous veins. Ore reserves are calculated across the entire width of the stockwork system. This produces a lower grade, bulk minable ore body with good continuity.

The veins are composed primarily of quartz. Pyrite is virtually the only sulphide mineral with only trace amounts of chalcopyrite. The gold content is directly related to the volume of vein quartz and more specifically to the volume of pyrite.

Glacial processes have had the dominant role in forming the geomorphology of the Sherman Creek valley. There is generally a thin, surficial vegetative mat which is underlain by silty clay tills. The tills can vary from being quite thin to over 180 feet thick before bedrock is encountered. In some areas, relatively clean alluvial, terraced sands and gravels have been found overlying the till.

The till in the project area is generally hard, dense, and over consolidated. Two major till units are present. The first unit is typically blue-gray in color and fine grained in texture. This unit was likely deposited below floating ice in glaciated basins subjected to substantial influxes of fine grained suspended sediment. It

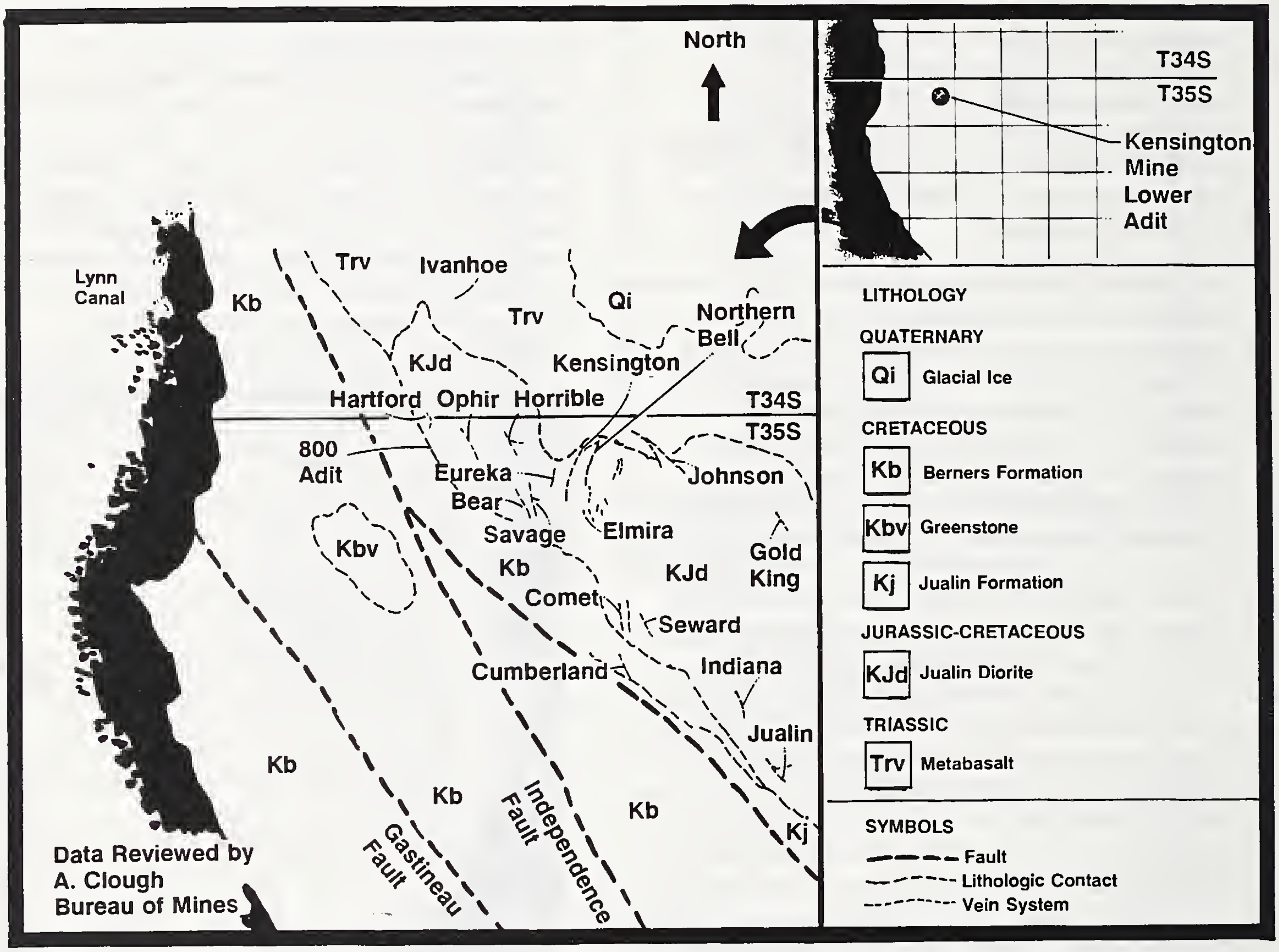


Figure 3-3, Geology

is predominantly composed of sandy, clean clays and silt with medium to low plasticity, sandy gravel which is fine to medium in texture. The second unit was derived from the activity of generally high energy braided meltwater streams through glacial material. In general, this material is green-gray in color, coarse grained in texture, and often cobbly. Due to their depositional history, the second unit soils are poorly sorted, silty gravel with sand and cobble/boulder constituents.

GEOTECHNICAL CONSIDERATIONS

EARTHQUAKE HAZARDS

The Kensington Project site is located within an area which is transversed by major regional faults that have a significant history of earthquakes. The Fairweather Fault, located approximately 70 miles west of the project site, was the location of a magnitude 8 earthquake in 1899 and a magnitude 7.7 earthquake in 1958. The Chatham Strait Fault has been mapped offshore of the project in Lynn Canal. This fault appears to be a splay or branch of the active Queen Charlotte Island fault (magnitude 8.1, 1949; and 7.7, 1972). Other faults exist in the area which have produced earthquakes of lower magnitudes. The Fairweather and Chatham faults are believed to be potential locations for regional earthquakes that may be of significance to the Kensington Project.

While the potential for high bedrock accelerations exists at the project site due to activity on the Fairweather and Chatham faults, there is no evidence of recent displacement or surface rupture (Holocene age or younger) on the three lineaments (linear topographic features) projecting through the site. Existing geologic maps identify two faults zones within the project area, Geomatrix (1988). These include the Gastineau Channel fault, which is mapped traversing Sweeny Creek, and the Independence Lake-Johnson Creek fault. The Gastineau Channel fault is mapped along Gastineau Channel near Juneau and is mapped as continuing northward along a topographic low expressed as a lineament by Slate Creek and Sweeney Creek in the project area. A photogeologic analysis and geologic literature review completed by Geomatrix (1988) revealed no evidence of Holocene or recent activity along the Gastineau Channel fault.

According to Geomatrix (1988), several faults and lineaments identified on aerial photographs also exist within a zone that extends southeastward from Independence Lake, passing near the proposed mill site, mine portal and Sherman Creek tailings alternative, through the dewatered tailings alternative area and then traversing the mountain ridge in two roughly parallel traces to the lower section of Johnson Creek. One of these traces extends from Sherman Creek to the Comet Mines and intersects Johnson Creek below the Jualin Mine. The other trace extends from Sherman Creek across the ridge and down Snowslide Gulch to Johnson Creek (Geomatrix, 1988). Interpretation of aerial photographs and review of geological literature completed by Geomatrix (1988) revealed no evidence of Holocene or recent activity along the Independence Lake - Johnson Creek faults.

The Slate Creek lineament appears to be a zone of step-over faults between Sweeny Creek lineament and the Johnson Creek lineament.

Earthquake data, including pre-1900 events, were evaluated for their impact to the Kensington site. Large magnitude earthquakes (greater than magnitude 8.0) were identified on the Fairweather Fault from as far back as 1899. Other large earthquakes have been identified on the Chatham Strait Fault, which is a splay of the Queen Charlotte Island Fault.

A detailed review of all earthquakes recorded from 1970 to 1990 at a radius of 200 kilometers from the site was performed as part of the seismic analysis for the Kensington project. This time frame corresponds with the installation of the Alaska Seismographic Network which was completed in 1971 (Lahr, 1991). This record provides a comprehensive catalogue of earthquake magnitudes for this area including micro-seismic activity. Micro-seismic data was not available for the project prior to the installation of the Alaska Seismographic Network in 1971. The selection of the 200 kilometer radius was designed to encompass an area which included the tectonic plate boundary

between the Pacific and North American Plates, where the greatest earthquakes have occurred in the past. In addition, earthquake attenuation curves developed for both bedrock and soil conditions (Seed and Iris, 1982) indicate significant attenuation of earthquake energy from the source of energy release. Beyond a 200 kilometer radius from the site for any given earthquake event, the peak horizontal bedrock acceleration is substantially dampened. Therefore, the bedrock acceleration for large earthquakes which have occurred on existing faults, Fairweather and Chatham Strait Faults, significantly attenuate over distance. According to documented literature (Seed and Iris, 1982), an earthquake which occurred 80 kilometers or further from the Kensington site would experience peak horizontal bedrock accelerations which are substantially less than the design accelerations used for this project.

As indicated, southeastern Alaska is a seismically active area which has experienced significant earthquake activity in the past. Since mid-1970 over 458 earthquakes have been recorded within a 200 kilometer radius of the Kensington Project site. Earthquakes occurring outside the 200 kilometer radius would not have any damaging effects to the proposed project. The majority of earthquakes occurring within the 200 kilometer radius zone have been small, ranging in magnitude from 2 to 4 on the Richter scale. There have been 84 seismic events registering a magnitude greater than 3.5. (*See DEIS Appendix Table D1-1, Earthquake Summary, 1970-1990*). Of these, 26 events occurred within the Denali-Shakwak Boundary which is the zone of seismic events that controls the engineering design criteria for earthquake events in the project area. (*See Figure 3-4, Earthquake Locations, 1970-1990*).

Seismic events in the Fairweather-Yakutat Boundary would have a lower magnitude than those within the Denali-Shakwak boundary due to the decrease in ground acceleration as the

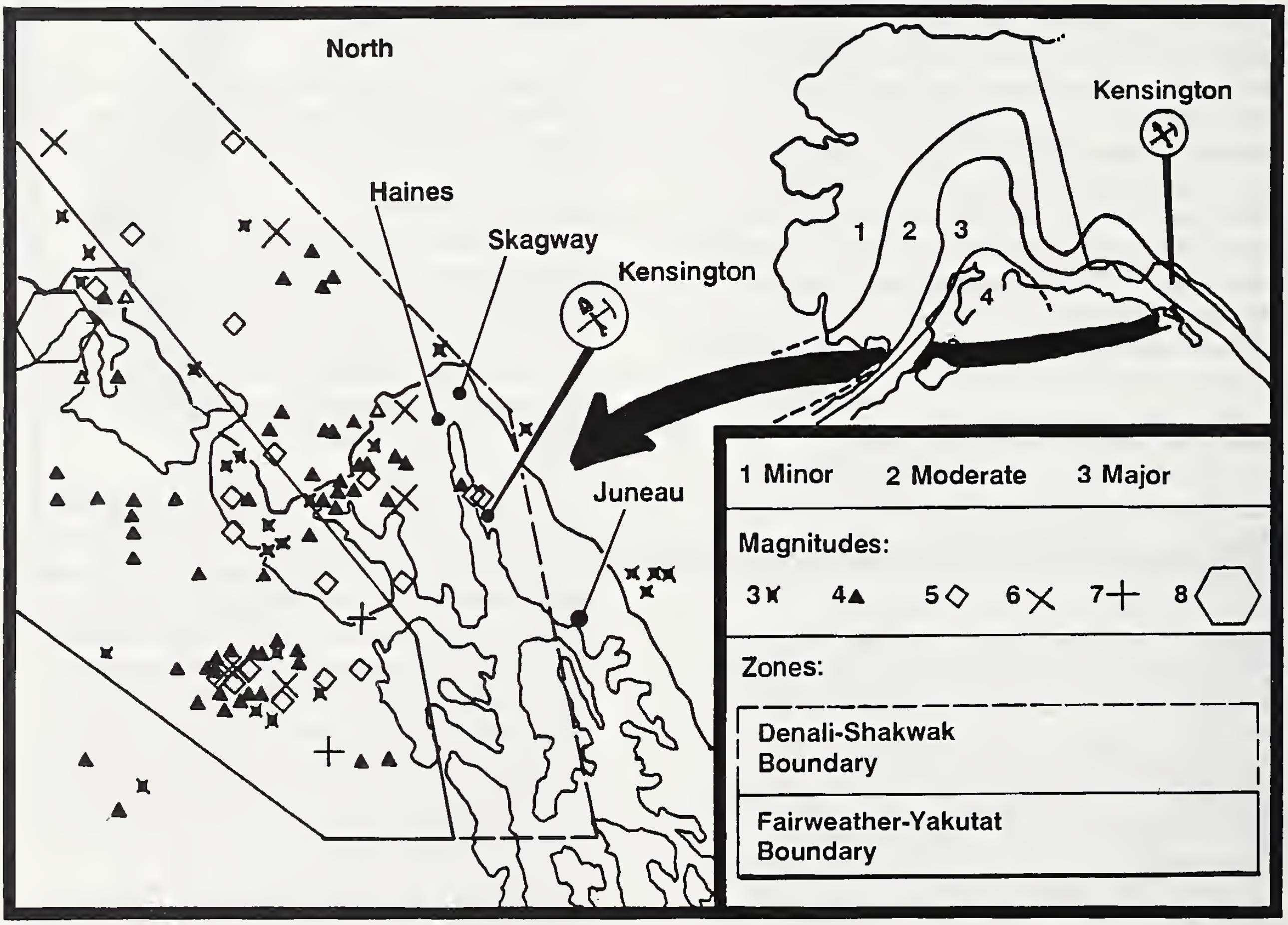
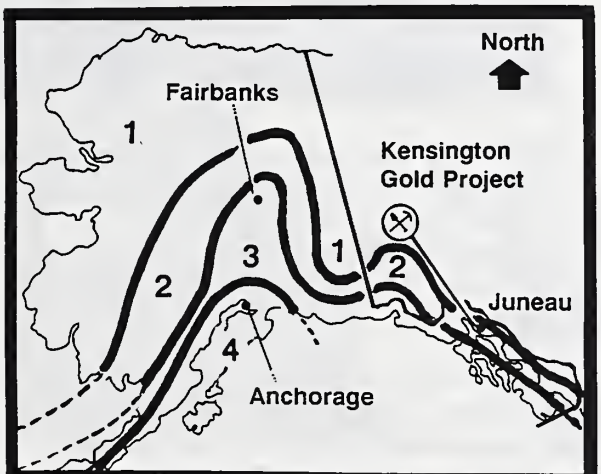


Figure 3-4, Earthquake Locations, 1970-1990

shock wave approaches the project area. Therefore, events within the Fairweather-Yakutat Boundary would register below the Maximum Credible Earthquake magnitude of 7.0 for the Denali-Shakwak zone.

The closest earthquake event to the Kensington Project site (approximately 11 km north) was a 5.0 magnitude earthquake, recorded on November 11, 1987. According to available information, including reconnaissance surface mapping performed by Geomatrix (1988), no surface disturbance or active faulting occurred at the Kensington site as a result of this event.

According to the Seismic Zone Map of Alaska (Uniform Building Code), the site lies within the Seismic Zone 2. (See *Figure 3-5, Earthquake Damage Potential*). This seismic zone relates to



Zone	Damage	Comment
1	Minor	Distant earthquakes may cause damage to structures with fundamental periods >1,0s; corresponds to intensities[1] V and VI
2	Moderate	Corresponds to intensity[1] VII
3	Major	Corresponds to intensity[1] >VIII
4	Major	Those areas within zone 3 determined by proximity to certain major fault systems

[1] Modified Mercalli intensity scale

Figure 3-5, Earthquake Damage Potential

a corresponding Modified Mercalli Intensity VII. An excerpt from the abridged and unabridged definition of an Intensity VII area is as follows:

> "Everyone runs outdoors; damage to buildings varies, depending on quality of construction, waves on ponds, turbid water with mud; slides and caving along sand or gravel banks...".

A comparison of earthquake accelerations for the Kensington Project indicates the floating or random earthquake located 15 kilometers from the site represents the greatest bedrock acceleration at the site.

OTHER GEOTECHNICAL CONSIDERATIONS

In all areas where slope conditions exceed 30 percent the susceptibility to landsliding, mass wasting, and avalanches exist. Slopes in the project area vary from level to vertical, with the majority of the slopes greater than 30 percent. Relatively gentle slopes are generally found at lower elevations in the alluvial flats and estuarine areas of Sherman, Sweeny and Ophir creeks. Relatively gentle slopes are found in upland areas although these are of limited areal extent. Steep slopes characterize most the Kensington Project area. They are common in the alpine and subalpine areas, in most of the ridgeline areas, along the incised portions of Sherman and Sweeny creeks, and along much of the project area bordering Lynn Canal.

Slopes were measured as the rate of change in elevation per 1,000 feet of horizontal (or map) distance and expressed as a percentage to develop a qualitative assessment of susceptibility to mass movement based on slope conditions. In general, where slopes were measured at less than 30 percent, an area was assigned a low hazard rating. Where slopes were measured to be in excess of 30 percent, an area was assigned a moderate to high hazard.

Low hazard areas are generally found at the lower elevations, and in the narrow alluvial floodplains of Sweeny and Sherman Creeks. On occasion, low hazard areas are found in the upland, subalpine valleys, although these areas are of limited extent. Low hazard areas represent a relatively small percentage of the total land area within the boundaries of the study area. The balance of the land area has been classified as having a moderate to high susceptibility to landsliding and mass movement, including avalanches.

Areas of historic landslides and or avalanches

were mapped. (*See Figure 3-6, Historic Avalanche and Landslide Areas*). Poorly

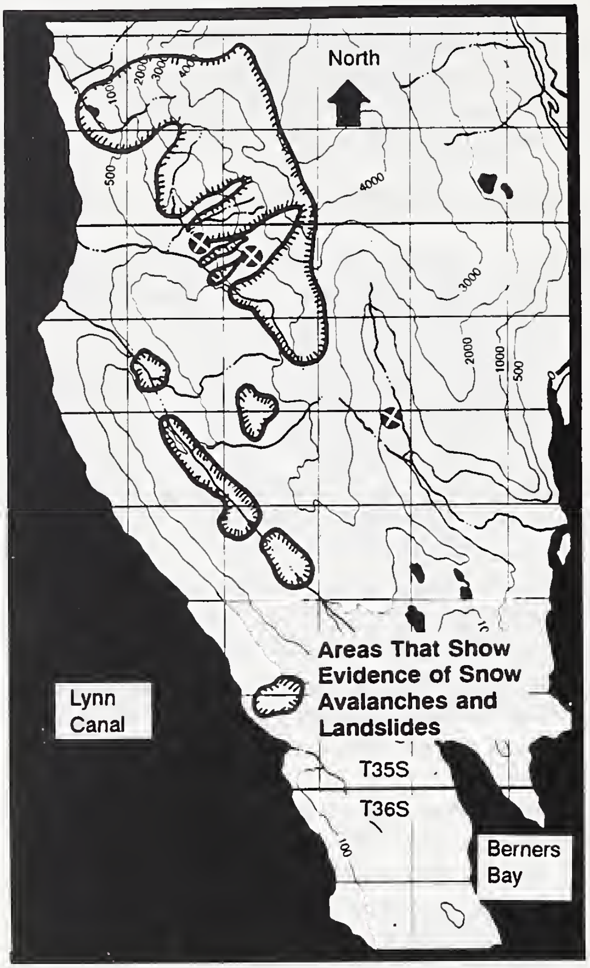


Figure 3-6, Historic Avalanche and Landslide Areas

drained soil conditions, unfavorable bedrock dip orientations, steep slope geometry, vegetative cover, and high snow loads create ideal conditions in portions of the project area for mass movement. In general these areas are concentrated in the steepest terrain. The area analyzed for snow avalanche and landslide activity is bounded by Lions Head Mountain to the north, Berners Bay to the south, and Lynn Canal to the west. Stereoscopic aerial photographs taken in July, 1962 and June, 1988 were the primary source of information for this analysis.

Areas indicated on *Figure 3-6, Historic Avalanche and Landslide Areas*, indicating evidence of mass movement (landslides and avalanches) were determined based on the following three criteria.

- Areas devoid of heavy spruce and hemlock forest which commonly covers most of the project area (frequent snow avalanche activity has resulted in the growth of shrub vegetation only)
- Relatively high (greater than 30 percent) slope angle
- Presence of snow accumulation (source) area, an avalanche path, and runout in the valley below the avalanche path

The potential for small rockfalls is present in areas other than those delineated on *Figure 3-6, Historic Avalanche and Landslide Areas*. These areas are generally of limited areal extent and were not mapped.

SURFACE WATER HYDROLOGY

Watersheds potentially affected by the proposed Kensington Project include Sherman Creek, Sweeny Creek, and Slate Creek. These drainages are all perennial and terminate at tidewater. (*See Figure 3-7, Watershed Boundaries*).

Storm events for the various drainages were calculated using the HEC-1, Flood Hydrograph Package developed by the U.S. Army Corps of Engineers. Low stream flow values were estimated from regional regression equations found in the Water Resources Atlas, Forest Service Region 10 (USDA Forest Service, 1979). Calculations were completed for 7 day, 10-year winter low flows and storm event flows for the various drainages. (*See Table 3-3, Hydrologic Data Summary*).

DESCRIPTION OF WATERSHEDS

There are four main physical properties that influence watershed hydrologic response to rain and snow. These properties are as follows.

- Climatic Characteristics
- Watershed Characteristics
- Soil Characteristics
- Vegetation Characteristics

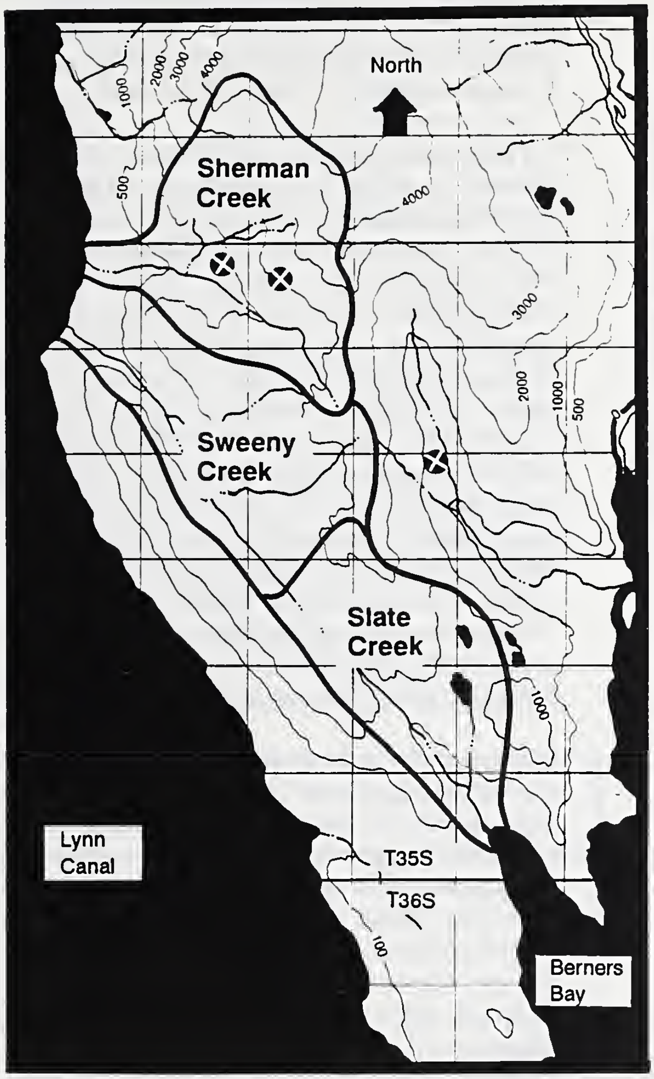


Figure 3-7, Watershed Boundaries

The climate at the Kensington Project site is characteristically maritime, influenced by currents in the Pacific Ocean which moderate temperature. Climate data exists from two stations near the site, Eldred Rock (period of record 1941, 1943-1973) and the Jualin Mine (period of record 1928-1929). Eldred Rock, located in Lynn Canal approximately 7.5 miles north of Comet, is the closest long-term weather station to the project site. Precipitation data from Eldred Rock was used to estimate the monthly distribution of average annual precipitation for the project site.

Sixty inches to over 110 inches of average annual precipitation at the project site is estimated in the Sherman, Sweeny, and Slate creek drainages (USDA Forest Service, 1979). This compares favorably with the figure of 70 inches listed as the mean annual precipitation during 1928 and 1929 at the Jualin Mine, the closest weather station to the Kensington Project site. Estimates of average annual precipitation at the project site are higher than those measured at the Eldred Rock weather station because of the influences of elevation and topography at the project site. (*See Air Quality and Climate, Chapter 3*).

The maximum 24 hour precipitation on record at both Juneau and Haines is 5.64 inches. This is consistent with the 10-year, 24 hour precipitation estimate for the Kensington site of 5.6 inches obtained from regional maps (USDC, Weather Bureau, 1963) (James M. Montgomery,

Table 3-3, Hydrologic Data Summary

Stream	Area (sq-mi)	20-year 7-day Low Flow (cfs)[1]	Average Annual Streamflow (cfs)[1]	Storm Events[2]		
				25-Year 24-Hour (cfs)	100-Year 24-Hour (cfs)	PMP (cfs)
Sherman Creek @ mouth	4.09	1.53	43	1,025	1,656	2,491
Sweeny Creek @ mouth	4.08	0.86	43	260	568	2,065
Slate Creek @ mouth	3.24	0.62	34	173	355	1,584

[1]Data estimated from Flowmod (Orsborn, 1991) by Paustian, 1992.

[2]Data from Surface Water Hydrology Evaluation, by the Kensington Venture, dated November 1989; Storm event calculated using HEC-1 Flood Hydrograph Model, developed by U.S. Army Corps of Engineers.

1988). (*See Table 3-4, Storm Event Precipitation*). Results of storm event modeling

Table 3-4, Storm Event Precipitation[1]

Storm Event	Precipitation (inches)
2 year, 24 hour	3.8
5 year, 24 hour	4.7
10 year, 24 hour	5.4
25 year, 24 hour	6.2
50 year, 24 hour	6.8
100 year, 24 hour	7.5
PMP[2] (Probable Maximum Precipitation)	15.8

[1]Data obtained from National Weather Service (USDC Weather Bureau, 1963).
[2]Data estimated from HMR-54 (USDC, NOAA, US Army Corps of Engineers, 1983).

(HEC-1) show that the Sweeny and Slate creek drainages generate less runoff per acre of watershed than Sherman Creek, primarily due to the flatter slopes and the lack off significant amounts of rock outcrops and snow fields at high elevations (Kensington Venture, 1989). Snowfall contributes an unknown but significant portion of the total annual precipitation, and this contribution increases with elevation.

Average annual evaporation for the Kensington Project site of 17.4 inches was derived from records kept at Juneau airport during the period of record from 1969 through 1979 (Knight and Piesold, Ltd., 1990).

Soil, vegetation, and watershed characteristics are all site specific measurable properties that were evaluated through field studies and analysis of topographic maps. Soil and vegetation conditions for each watershed in the project area are described in a subsequent section (*See Soils/Vegetation/Wetlands, Chapter 3*).

Sherman Creek

Sherman Creek flows from the base of Horrible Hill and discharges into Lynn Canal at Comet Beach. The upper reaches of the Sherman Creek valley are heavily impacted by avalanches and rock slides. The lower reaches are in low lands characterized as second growth rain forest. Elevation in the Sherman Creek drainage ranges from 0 to 5,552 feet MSL.

A hydrologic soil group analysis was performed on the soils in the project study area based on the results obtained from Dames & Moore (1989c). It was determined that hydrologic soil group "B" best represents the Sherman Creek drainage basin. Soils in the hydrologic soils group "B" have moderate infiltration rates, when thoroughly wetted, and have a moderate rate of water transmission. Study area soils are covered with a thick, very permeable peat layer with an underlying layer of typically clean sands and gravels. Much of the surficial material in this drainage is derived from fine texture tills. These deposits also are found on gentle side slopes. The presence of shallow ground water is determined by the thickness of permeable soils and the gradients of local slopes. (*See Soils/Vegetation/Wetlands, Chapter 3*).

Vegetation in the Sherman Creek drainage is represented by closed hemlock/spruce forest. Alder occurs on disturbed sites and alluvial terraces. Understory vegetation is represented by muskeg and low growing woody vegetation. (*See Soils/Vegetation/Wetlands, Chapter 3*). Canopy cover density ranges from 80 to 100 percent. Ground cover density is 100 percent, except in areas where rock outcrops occur (Kensington Venture, 1989).

There are three principal tributaries of Sherman Creek: upper Sherman Creek, Ophir Creek and tributaries, and an unnamed tributary which flows into Sherman Creek from the south downstream of upper Sherman Creek.

The Ophir Creek tributary of Sherman Creek is steep, rocky, and not well vegetated. Consequently, runoff from Ophir Creek is fast, accounting for up to 90 percent of the peak flows to lower Sherman Creek (Kensington Venture, 1989). Channel characteristics of Sherman Creek and Ophir Creek are described in greater detail under *Aquatic Resources, Chapter 3*.

The USGS maintained and operated a gage at Sherman Creek from September, 1914 to December 1917. This station (historic Sherman

Creek) was located 0.8 miles from the mouth of Sherman Creek at an elevation of 400 feet. In order to determine if the short-term historic Sherman Creek data could be considered representative of current conditions, historic stream flow data for a gaging station with a long-term period of record, located near the Sherman Creek gage, was researched. The Gold Creek gage at Juneau provided measurements during the 1917 to 1920 period, in addition to more recent records (1945 to 1982). A mean annual flow at Gold Creek for 1917 to 1920 of 104.8 cubic feet per second (cfs) was nearly identical to the long-term mean annual flow of 104.6 cfs. With this comparison it can be reasonably assumed that the short-term average annual flow recorded at the Sherman Creek gage (30.8 cfs) will be a good indication of the average flow that could be expected at the site. (*See Table 3-5, Mean Monthly Flows for Sherman Creek*). The maximum observed discharge at the historic USGS gage on Sherman Creek was 208 cfs.

Table 3-5, Mean Monthly Flows[1] for Sherman Creek

Month	Streamflow (cfs)	(gpm)
January	6.8	3,049
February	7.6	3,407
March	16.0	7,173
April	28.0	12,533
May	47.0	21,072
June	61.0	27,348
July	37.0	16,588
August	50.0	22,417
September	46.0	20,623
October	44.0	19,727
November	20.0	8,967
December	6.4	2,869
Mean Annual	30.8	13,809

[1]Data based on results obtained from USGS gaging station located 0.8 miles from the mouth of Sherman Creek at an elevation of 400 feet. Period of record, 2 1/3 years, 1914 through 1917.

Stream flow has been continuously measured at monitoring stations on Sherman and Ophir creeks from 1988 to present. (*See Figure 3-8, Surface Water Monitoring Sites*). Monitoring commenced in Ophir Creek during July, 1988, in lower Sherman Creek during October, 1988, and on upper Sherman Creek during November, 1988. Monitoring has been disrupted at these stations periodically due to severe weather conditions. An additional monitoring station was added to the monitoring network on Ophir Creek in April, 1991.

Based on records currently available, the stream flow at the upper Sherman Creek monitoring station (no. 109) ranged from 0.48 cfs (February 21, 1990) to 203 cfs (March 5, 1990). Upper Sherman Creek was initially monitored at station no. 104 for three months from May 24, 1988 through July 26, 1988. Station no. 104 was moved downstream to a more stable stream section (station no. 109) with a better hydraulic cross-section and less bed-load movement. The relocation of this station does not affect the integrity of the monitoring network because it was moved early in the program and water quality data collected from station no. 104 does not vary significantly from later sampling at station no. 109.

Ophir Creek tributary flows (station no. 103) ranged from 0.0 cfs (during November, December, 1990 and April, 1991) to 36 cfs (November 30, 1988). Minimum stream flows may have been greater than zero but were not large enough to accurately measure. Monthly monitoring of North Ophir Creek was initiated April 29, 1991. Flows ranged from 5.01 cfs (May 13, 1991) to 30.28 cfs (June 22, 1991). Continuous monitoring at this site was initiated in July, 1991.

Lower Sherman Creek flows ranged from 3.1 cfs (January 12, 1991) to 232 cfs (October 1, 1990). The seven-day average low flow with a twenty-year recurrence interval (7Q20) at the mouth of Sherman Creek is estimated to be 1.53 cfs or 685 gpm (Paustian, 1991). Weekly stream flow monitoring 10 feet below the lower Sherman Creek station (no. 105) and 10 feet below the upper Sherman Creek station (no. 109) was initiated January 5, 1991. Flows measured at these sites during January, 1991 ranged from 1.16 to 1.98 cfs in upper Sherman Creek and from 3.45 to 5.65 cfs in lower Sherman Creek. Continuous monitoring data for upper Sherman

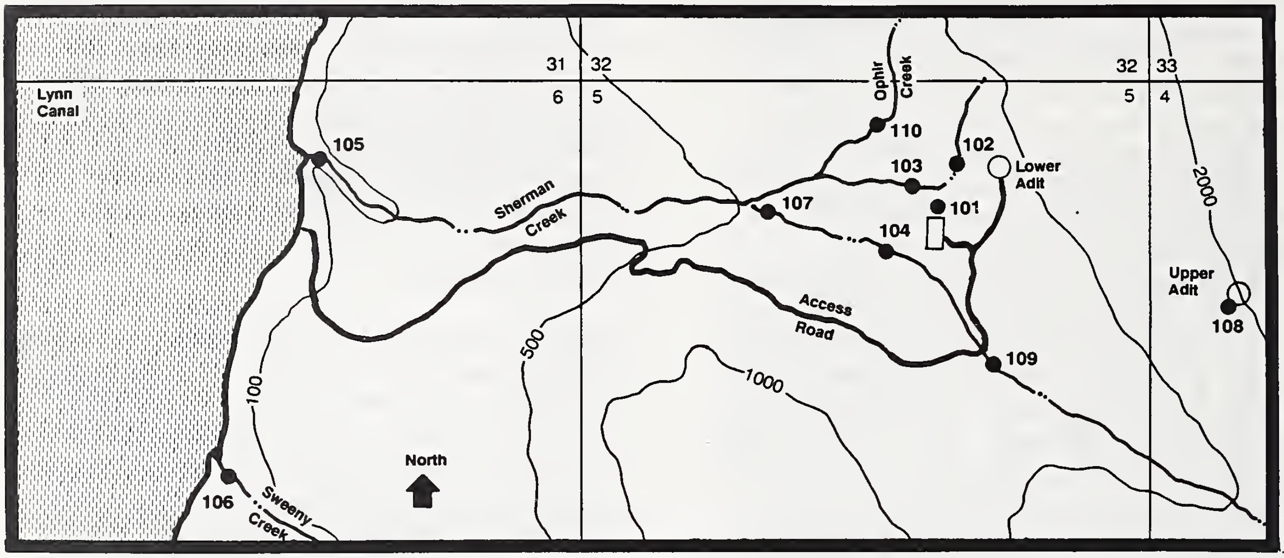


Figure 3-8, Surface Water Monitoring Sites

Creek were not available for comparison during this period. On average, continuous monitoring in lower Sherman Creek compared reasonably well with weekly monitoring. A winter thaw in late January resulted in increased flows. The weekly monitoring was discontinued as its purpose was to record low winter flows. The magnitude of winter flows in 1991 were in agreement with the low flow ranges from continuous monitoring in previous years.

Sweeny Creek

Sweeny Creek flows from the southeast to the northwest and discharges into a bay of Lynn Canal about 1,500 feet north of Point Sherman. The creek flows through a very steep-sided, narrow valley, and evidence of past landslide activity is apparent in the upper portion of the drainage. Elevation in the Sweeny Creek drainage ranges from 0 to 2,700 feet MSL.

Soil cover is thin and is estimated to be about 2 to 4 feet thick. The stream gradient is very steep and the stream bottom is generally composed of cobbles and boulders (Echo Bay Exploration, Inc. and Coeur d'Alene Mines, Corp., 1990). A description of stream channel characteristics is provided in a subsequent section. (*See Aquatic Resources, Chapter 3*).

Vegetation in this area consists of hemlock/spruce forest near the beach, grading to open muskeg/shore pine forest at higher elevations. (*See Soils/Vegetation/Wetlands, Chapter 3*). The sides of the valley are heavily wooded with large spruce. The trace of the Gastineau Channel Fault is projected to follow the alignment of Sweeny Creek.

Stream flow is monitored in Lower Sweeny Creek, monitoring station no. 106. The station was monitored from October 1988 through January, 1989 and from September 1989 to present. Based on currently available information, stream flow in lower Sweeny Creek ranged from 0.0 cfs (March, July, August, and September, 1990) to 241 cfs (November 30, 1988). Again, minimum stream flows may have been greater than zero but were not large enough to accurately measure. The seven-day average low flow with a twenty-year recurrence interval (7Q20) at the mouth of Sweeny Creek is estimated to be 0.86 cfs or 386 gpm (Paustian, 1991).

Slate Creek

Slate Creek is located south of the Sherman Creek and Sweeny Creek watersheds. Slate Creek drains into Berners Bay. Elevation in the Slate Creek drainage ranges from 0 to 2,520 feet MSL. The north fork tributary of Slate Creek drains into a series of small lakes which are located on a south facing terrace with relatively thin tree cover. Channel

characteristics of Slate Creek are described in greater detail under *Aquatic Resources, Chapter 3.*

Soil characteristics of the Slate Creek drainage appear to be similar to the Sherman Creek drainage based on field observations and evaluations of aerial photographs (Echo Bay Exploration, Inc. and Coeur d'Alene Mines, Corp., 1990).

Vegetation types in the Slate Creek drainage include grass-sedge meadow, lake shore wetland, and hemlock/spruce forest. (*See Soils/Vegetation/Wetlands, Chapter 3*).

The seven-day average low flow with a twenty-year recurrence interval (7Q20) at the mouth of Slate Creek is estimated to be 0.62 cfs or 278 gpm (Paustian, 1991).

SURFACE WATER QUALITY

Sherman Creek

Surface water quality data for the Sherman Creek drainage were obtained from five monitoring stations. Upper Ophir Creek (station no. 102), Ophir Creek tributary (station no. 103), North Ophir Creek (station no. 110), Upper Sherman Creek (station no. 104 and later 109), and Lower Sherman Creek (station no. 105). Several water quality samples were also collected at the proposed mill site (station no. 107). (*See Figure 3-8, Surface Water Monitoring Sites*). Baseline water quality monitoring was initiated in October, 1988 and continues to be collected. The Draft EIS discussed water quality from the period of October, 1988 through October, 1990. Water quality data collected from November, 1990 through June, 1991 was available for the Final EIS.

Laboratory procedures used for analyses of water quality data followed U.S. Environmental Protection Agency recommended guidelines. However, due to public comments received, methods used for analyses were changed, thereby lowering detection limits, for the following parameters: copper, lead, mercury, silver, selenium and zinc. Analyses reflecting these changes began in September, 1991. A history of the analytical methods used and changes made are found in IML, 1992.

Sherman Creek water is of calcium bicarbonate-sulfate type with low alkalinity and hardness. The content of total dissolved solids ranged from 16 to 194 mg/l with a median value of 55 mg/l (October, 1989 through October, 1990). The pH ranged from 6.0 to 7.8 units with a median value of 7.3. The median values for the period October, 1988 through October, 1990 for all metals monitored were less than laboratory detection limits. Additional data collected from November, 1990 through June, 1991 was consistent with the previous period of record.

Water quality in Ophir Creek is similar to the water in Sherman Creek, with occasionally high amounts of total dissolved solids (996 mg/l on March 22, 1990, Ophir Creek tributary, station no. 103). The total dissolved solids at Ophir Creek tributary and upper Ophir Creek ranged from 22 to 996 mg/l with a median value of 68.5 mg/l (October, 1989 through October, 1990). The higher total dissolved solids values occurred during winter and early spring periods and corresponded to high total dissolved solids values in the sedimentation pond (station no. 101). Station no. 101 represents mine water originating from the 850- foot level. (*See Ground Water Hydrology, Chapter 3*). The pH in Ophir Creek ranged from 5.7 to 7.6 with a median value of 7.0 (October, 1988 through October, 1990).

The median values for all metals monitored in Ophir Creek were below laboratory detection limits with the exception of dissolved iron (0.05 mg/l), and total manganese (0.03 mg/l). However, these values were within the range of concentrations typical of natural waters in the Juneau area. Again, data collected during November, 1990 and June, 1991 was consistent with the previous period of record (October, 1988 through October, 1990).

Three months of data (April, 1991 through June, 1991) were available for the north Ophir Creek station (no. 110). Monitoring at this station was initiated to provide additional undisturbed water quality data for Ophir Creek. Upper Sherman Creek (station no. 109) and Sweeny Creek (station no. 106) are also undisturbed drainages. A comparison of north Ophir Creek and Ophir Creek tributary show that the water quality in Ophir Creek tributary is influenced by the sedimentation pond (station no. 101). Minimum

values for the following parameters were slightly less in North Ophir Creek than at Ophir Creek tributary: turbidity, nitrate as N, nitrate+nitrite as N, sulfate, total dissolved solids, and hardness. This comparison was based on only three months of data and the differences in concentrations were small.

Water quality of mine waters are represented by station no. 101 (850-foot level) and station no. 108 (2000-foot level). These stations are discussed in detail in *Ground Water Hydrology, Chapter 3.*

Elevated concentrations of nitrates were noticed in the Kensington Project area surface streams and ground water during the monitoring period beginning the summer of 1988. The increased nitrates content in the sedimentation pond for short periods of time could be caused by a spill of ammonia nitrate explosives (ANFO) used in the underground workings. After detonation the residual nitrates are not in a soluble form, and, therefore, only spills and/or unexploded ANFO could contribute nitrates to surface and ground water. Nitrate concentration peaks in September, 1989 and June, 1990 could be caused by unexploded ANFO. However, the average nitrate concentrations from June, 1988 through June, 1991 was higher at the Ophir Creek tributary (station no. 103) than it was at the sedimentation pond (station no. 101, located upstream of station no. 103).

There may also be some natural sources of nitrate, contribution from muskeg, that may cause slight increases in nitrate concentration. Concentrations of nitrate for July, 1989 were considered to be laboratory or sampling error. All stations during this month, including undisturbed lower Sweeny and upper Sherman Creek showed concentrations out of line with all other nitrate concentrations.

Sulfate concentrations at all monitoring points indicated that the sedimentation pond (station 101), or waters originating from the underground exploration area, are a sulfate source and sulfate is being diluted downstream. Sulfate may be added to mine waters from blasted material during exploration. However, there has been no decrease in pH of any of these streams as a result of exploration activity.

Some values of total cyanide were observed in baseline data from Sherman and Ophir creeks above the 0.005 detection limit. However, most of the observed cyanide measurements are near or below the generally accepted sensitivity limit of 0.02 mg/l. The laboratory used U.S. Environmental Protection Agency recommended method 335.2, including pre-treatment with sulfuric acid to avoid nitrate/nitrite interference (EPA, 1980). There are no known natural sources of cyanide in surface waters within the project area. There also has been no use of cyanide reagents by Kensington Venture to date at the project site. It is also possible that these were false readings resulting from interference from high nitrate concentrations in the water samples even though pre-treatment was used (Spannagel, 1991; Intermountain Laboratories, 1991).

Sweeny Creek

Surface water quality monitoring in Sweeny Creek was initiated in May, 1988. One monitoring station is located in the lower reaches of Sweeny Creek. Sweeny Creek is considered an undisturbed drainage because there has been no history of mining or exploration in this drainage.

Sweeny Creek water quality is of bicarbonate calcium type with a low content of total dissolved solids ranging from 20 to 106 mg/l, with a median value of 62 mg/l (May, 1988 through October, 1990). The pH ranged from 6.6 to 7.9, with a median value of 7.3. Surface water quality in Sweeny Creek is similar to the surface water quality in Sherman Creek, with a generally lower content of dissolved solids. The trace metals content was predominantly below the laboratory detection limits. The median values for all metals were below laboratory detection limits with the exception of dissolved and total iron (0.07 and 0.09 mg/l, respectively). Water quality data collected from November, 1990 through June, 1991 was consistent with the previous period of record (May, 1988 through October, 1990) with the exception of chloride. Concentrations of chloride in the later period of record were greater than the maximum recorded previously by up to 7 mg/l.

WATER RIGHTS

Research of the files at the Alaska Department of Natural Resources has revealed that there are no water rights in the project area (Sherman, Sweeny, and Slate creek drainages) other than those filed by the Applicant. A temporary authorization to use some water at the site has been granted for exploration operations. Water for the project would eventually come from surface water and ground water wells that would be established and maintained for the life of the project. Water rights would be obtained from the Alaska Department of Natural Resources.

GROUND WATER HYDROLOGY

Historically, water inflow into mines in southeastern Alaska have hampered mining efforts. The Treadwell Mine which was located near Juneau was flooded by seawater from the Gastineau Channel in 1917 (Stone, 1980). In the Comet Lode Mine, located near the Kensington Mine, heavy flooding on the lower levels of the mine forced operation to cease in 1897 (Rogers, 1917). The lowest drift at this mine was driven at an elevation of approximately 1,650 feet.

The Jualin Mine in Johnson Creek has an adit elevation of approximately 750 feet and experienced heavy inflow of water at deeper levels until water inflow actually impeded ore extraction in 1901.

DESCRIPTION OF GROUND WATER RESOURCES

Ground water at the Kensington Project has been characterized for the following locations.

- Underground Mine
- Proposed Mill and Tailings Site and Alternative (E) Dewatered Tailings Site - Sherman Creek
- Alternative (D) Tailings Site - Sweeny Creek

Underground Mine

Ground water has been encountered during the underground exploration activities at the site. Present mine water discharge is variable, ranging from approximately 100 to 400 gallons per minute. The majority of the water enters the exploration workings along a fracture system, oriented northwest-southeast within the mine, with water movement occurring along fractures and faults of the mineralized zones. It appears that water discharges rapidly into the exploration workings at the time of face opening or drilling, but this inflow decreases rapidly over time. Seasonal variation in ground water inflow is also expected due to the fluctuation of water infiltration into the overlying strata.

Water flow into the Kensington Mine depends primarily on fracture (secondary) permeability. Water bearing faults and/or fracture systems connected with the recharge areas at the surface are conduits for mine inflow. The recharge potential is high due to the high average annual precipitation (up to 100 inches) and accumulations of snow.

Facilities Site (Alternatives B, C, D & E), Tailings Site (Alternative B & C), Dry Tailings Site (Alternative E)

A number of ground water monitoring wells have been installed in the Sherman Creek drainage. *(See Figure 3-9, Ground Water Monitoring Wells)*. Water levels have been measured in various boreholes and monitoring wells. Water level monitoring data have been used to develop a potentiometric surface map *(See Figure 3-10, Potentiometric Surface Map)*. The general trend indicates that the potentiometric surface conforms to surface topography, and ground water flow direction is generally east to west toward Lynn Canal. Along the monitored section of Sherman Creek, ground water from the till and bedrock discharges into the stream throughout the year.

Five different geologic units were defined in the Sherman Creek drainage area (Dames and Moore, 1990a).

- Surficial Peat
- Alluvial and Terrace Sands & Gravels
- Blue-gray Glaciolacustrine Clayey Till
- Green Glaciofluvial Till
- Phyllite Bedrock

These units were defined by analysis of

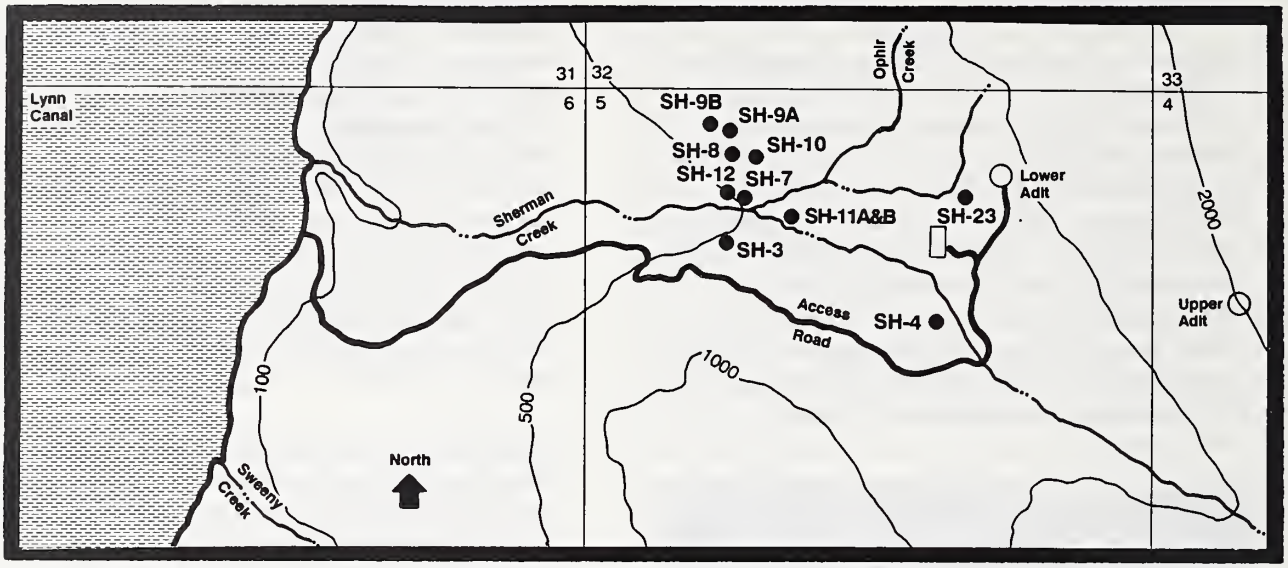


Figure 3-9, Ground Water Monitoring Wells

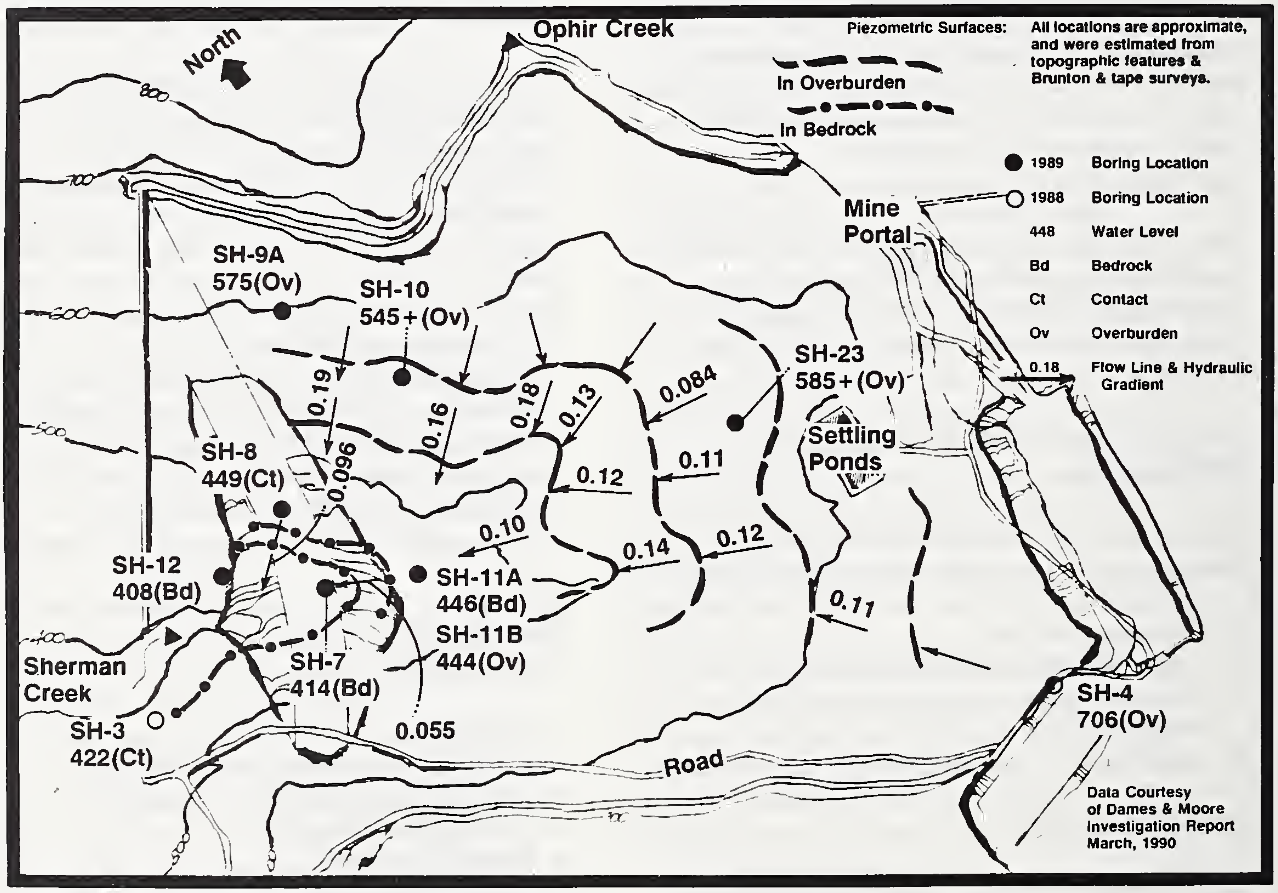


Figure 3-10, Potentiometric Surface Map

These units were defined by analysis of geologic data collected from the monitoring well drill holes and other geologic sampling locations. (*See Figure 3-11, Geologic Sample Sites*).

proposed Sherman Creek tailings facility. The range of hydraulic conductivity for the alluvial sand and gravel was calculated as approximately 2.8×10^{-1} to 2.8×10^{1} ft/day (9.9×10^{-5} to 9.9×10^{-3} cm/sec).

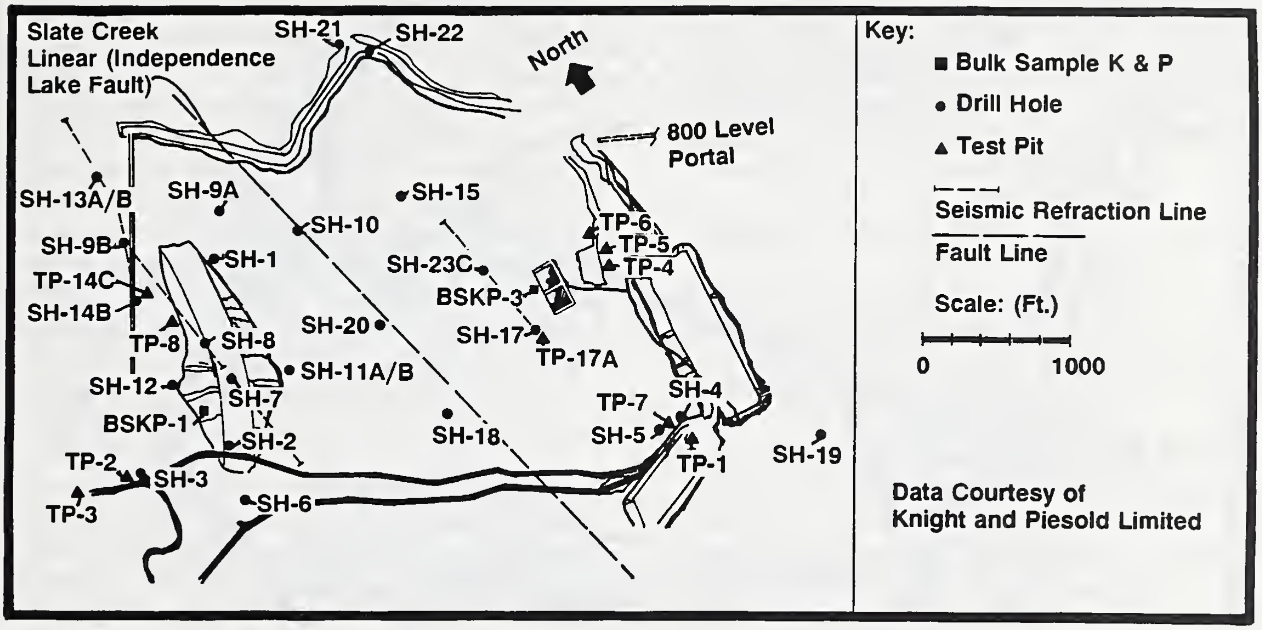


Figure 3-11, Geologic Sample Sites

Ground water occurs in all five units. In general, these geologic units equate to three hydrogeologic units, alluvial and terrace sands and gravels, till, and phyllite bedrock. The surficial peat is not important for ground water flow because it is relatively thin. Within the three hydrogeologic units, perched and saturated zones were encountered during drilling.

Generally, in the alluvial and terrace sands and gravels and till units, ground water flows in lenses of gravels and sands and is confined by silts and clays. The sand and gravel lenses may be discontinuous, which is typical of glaciofluvial deposits. Ground water flow in the bedrock occurs primarily along fractures.

The first hydrogeologic unit is composed of alluvial and terrace sands and gravels which bound the area creeks. (*See Figure 3-12, Sherman Creek Drainage Geologic Units and Figure 3-13, Cross Sections of Sherman Creek Geologic Units*). This unit covers most of the area of the proposed tailings facility in Sherman Creek. It is assumed that most of this unit would be excavated during construction of the

The second hydrogeologic unit is composed of till and discontinuous lenses of sorted sands and gravels which underlie most of the Sherman Creek drainage. This unit can be divided into two subunits, the blue till and the green till. The blue till is finer grained and more uniform than the green till deposits. The hydraulic conductivity of the blue till, based on field testing, ranges from 4.3×10^{-3} to 2.8×10^{-2} ft/day (1.5×10^{-6} to 9.9×10^{-6} cm/sec). This unit is found in the central part of the proposed tailings storage facility area. (*See Figure 3-12, Sherman Creek Drainage Geologic Units and Figure 3-13, Cross Sections of Sherman Creek Geologic Units*).

The green till is heterogeneous and generally coarser grained than the blue till. The hydraulic conductivity of this unit, based on field tests, ranges from 2.5×10^{-3} to 2.3 ft/day (8.8×10^{-7} to 8.1×10^{-4} cm/sec). The green till is found along the perimeter of the proposed tailings storage area. (*See Figure 3-12, Sherman Creek Drainage Geologic Units and Figure 3-13, Cross Sections of Sherman Creek Geologic Units*).

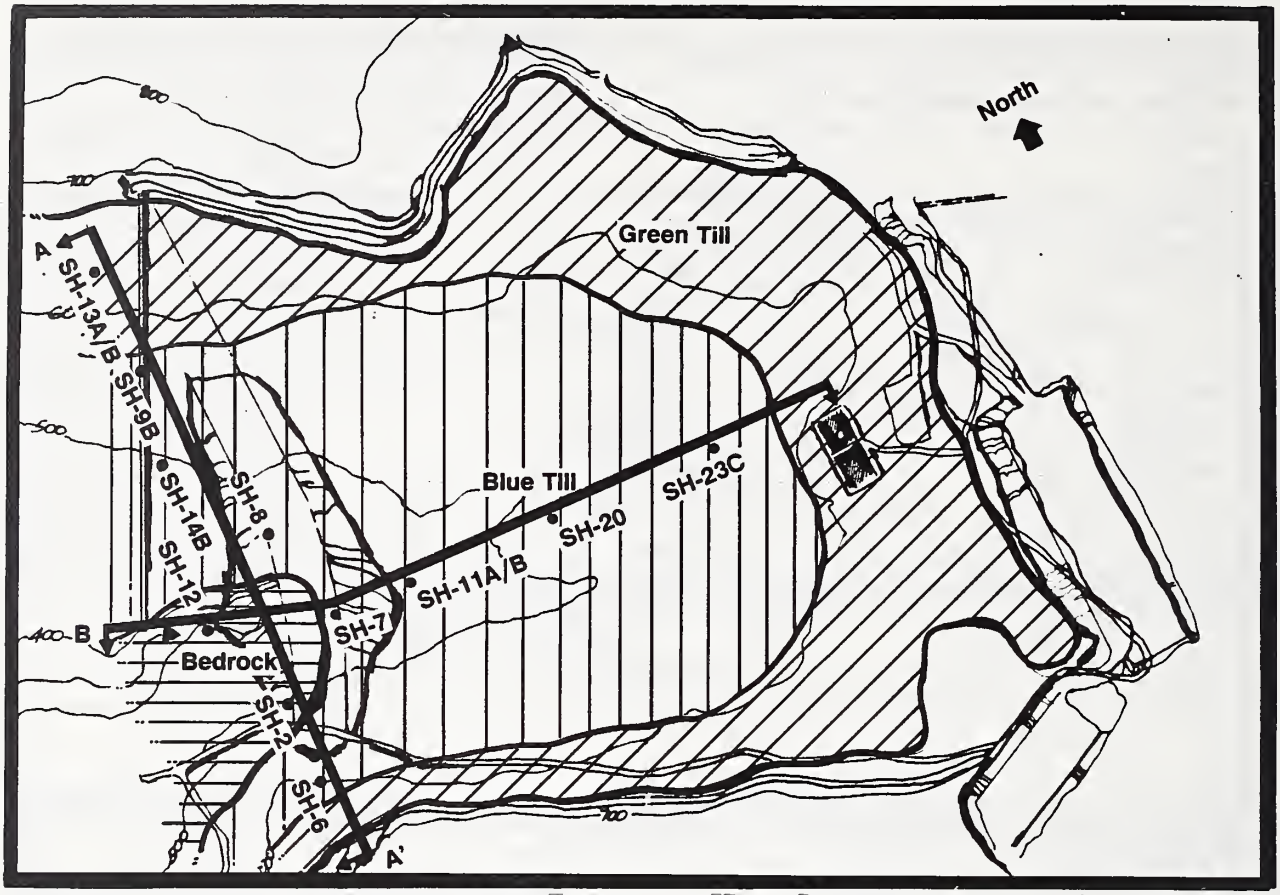


Figure 3-12, Sherman Creek Drainage Geologic Units

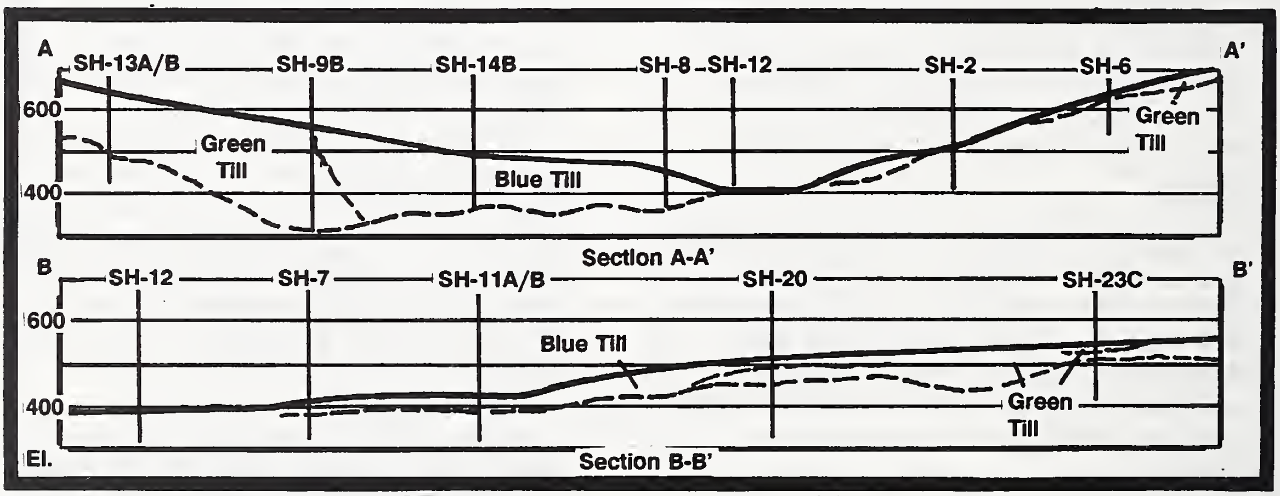


Figure 3-13, Cross Sections of Sherman Creek Geologic Units

The third hydrogeologic unit is the phyllitic bedrock. This unit outcrops along the tailings embankment and in the upper reaches of Sherman Creek. (*See Figure 3-12, Sherman Creek Drainage Geologic Units and Figure 3-13, Cross Sections of Sherman Creek Geologic Units*). The hydraulic conductivity of the bedrock, based on field tests, ranged from 8.8 x 10^{-4} to 2.1 x 10^{-2} ft/day (3.1 x 10^{-7} to 7.4 x 10^{-6} cm/sec).

Recharge into the ground water system originates mostly from direct infiltration of precipitation and snowmelt. The indirect infiltration from the losing sections of the local streams is negligible because major parts of the streams have a gaining character throughout the project area. Recharge into the ground water system was estimated at 15 to 20 percent of the average annual precipitation. This estimate is based on the results of studies by Gieck and Kane (1986) and Bauer and Vaccaro (1988) and on a comparison of the climatic and soils characteristics of the referenced study areas (near Fairbanks, Alaska and the Columbia Plateau in Washington, Oregon, and Idaho) and the Kensington site. The project site is covered mostly by soils of the hydrologic group "B" with moderate infiltration rates when thoroughly wetted.

The rate of ground water recharge is influenced by seasonally frozen soils. According to Munter (1986), who completed a study of ground water recharge through frozen soils at Anchorage, Alaska, the major reason for the reduced recharge in most areas where soils are frozen during part of the year is the unavailability of water, rather than the reduced permeability of frozen soils.

The rate of ground water recharge in climatological settings without significant seasonally frozen soils was estimated at 35 percent of annual precipitation by Bauer and Vaccaro (1988). These authors calculated the annual recharge to the Columbia Plateau region in Washington, Oregon, and Idaho in 53 referenced zones. The recharge value of 35 percent of annual precipitation was based on reference zones that were forested, undeveloped, and had relatively high annual precipitation.

Discharge from the ground water system occurs along the local drainages and into Lynn Canal.

Alternative (D) Tailings Site - Sweeny Creek

The geologic and soil characteristics of the Sweeny Creek drainage were determined by helicopter reconnaissance and by walking the creek bed.

The site investigation performed by Dames & Moore (1989c) concluded that geologic and soil conditions at Sweeny Creek would be similar to those encountered at Sherman Creek. Therefore, till and bedrock are the main water bearing strata in the Sweeny Creek drainage. The ranges of the hydraulic conductivity should be similar to those measured at Sherman Creek. The ground water table in the water bearing strata is near the ground surface, and Sweeny Creek should be a gaining stream.

GROUND WATER QUALITY

Ground water quality has been monitored during exploration operations in the underground mine and in nine monitoring wells during the period from June, 1988, to present.

Samples of water were taken from both the 2,000 foot level and the 850 foot level adits. It should be noted that ground water quality samples of water flowing from the lower adit were taken at the sediment pond outlet.

The Draft EIS discussed water quality from the period of June, 1988 through October, 1990. Water quality data collected from November, 1990 through June, 1991 was available for the Final EIS. Laboratory procedures used for analyses of water quality data are described in *Surface Water Quality, Chapter 3*.

Underground Mine

The water discharged from the 850 foot level adit and sampled at the sedimentation pond is of calcium sulfate type with a range of total dissolved solids (TDS) from 300 to 1,268 mg/l with a median value of 742 mg/l and pH of 7.0 to 8.0 with a median value of 7.8 (June, 1988 through October, 1990). The median values for the period June, 1988 through October, 1990 for most metals monitored were less than laboratory detection limits with the exception of the following: total aluminum (0.10 mg/l, at detection limit), total iron (0.43 mg/l), dissolved manganese (0.02 mg/l, at detection limit), total manganese (0.07 mg/l), dissolved molybdenum (0.04 mg/l), and total molybdenum (0.06 mg/l). The median concentrations reported above detection limits are within the range of concentrations typical of natural waters in the Juneau area. Additional data collected from

November, 1990 through June, 1991 was consistent with the previous period of record.

Water samples collected at the 2,000 foot level adit are of calcium bicarbonate type. The TDS content on this level was substantially lower than at the lower level. The TDS content ranged from 46 to 102 mg/l with a median value of 81 mg/l and the pH ranged from 6.7 to 7.9 with a median value of 7.7 (May, 1988 through May, 1989). The median values for the period May, 1988 through May, 1989 for all dissolved metals (total metals were not measured during this period) were less than laboratory detection limits with the exception of dissolved copper (0.006 mg/l) and dissolved zinc (0.004 mg/l). There was no additional monitoring at this site after May, 1989.

Mill and Tailings Site - Sherman Creek

Four of the nine wells (SH-7, SH-8, SH-10, and SH-11A) were contaminated by grout during installation. The contamination resulted in unreasonably high pH values. These four wells were not used in the ground water quality characterization.

Five monitoring wells (SH-3, SH-4, SH-9A, SH-11B, and SH-12) were used for the ground water quality evaluation. These wells have been sampled monthly from the fall of 1989 to present. Two monitoring wells SH-9B and SH-23 were added to the monitoring network in the spring of 1990.

Ground water in the Sherman Creek drainage is of bicarbonate calcium type with a range of TDS from 21 to 479 mg/l and a median value of 160 mg/l. The pH ranged from 6.0 to 9.9, with a median value of 7.9 (August, 1989 through October, 1990). Median concentrations for metals measured for the August, 1988 through October, 1990 period were below laboratory detection limits with the exception of the following: total aluminum (3.00 mg/l), total arsenic (0.01 mg/l), total copper (0.06 mg/l), dissolved and total iron (0.05 and 9.52 mg/l, respectively), dissolved and total manganese (0.04 and 0.75 mg/l, respectively), total nickel (0.01 mg/l, at detection limit), and total zinc (0.07 mg/l). Additional data collected from November, 1990 through June, 1991 was consistent with the previous period of record.

Sweeny Creek

Ground water quality samples have not been collected, at this time, in the Sweeny Creek drainage. From a comparison of the available surface water quality data for Sweeny Creek with surface and ground water quality data in Sherman Creek, it is possible to make the following assumption. The ground water in the Sweeny Creek drainage is of bicarbonate calcium type, with a low value of total dissolved solids and a pH of about 7.5.

AQUATIC RESOURCES

Site-specific field studies, regional published reports and other literature, and agency file data were reviewed to obtain information on the aquatic resources of the area. These sources were supplemented through interviews with biologists having expertise of the area or the species inhabiting those waters. Relevant findings are presented in the following sections.

- Oceanography
- Marine Biota
- Commercial Fisheries
- Freshwater Biota

OCEANOGRAPHY

The proposed project is situated along the eastern shore of Lynn Canal. This body of water and its southern extension, Chatham Strait, constitute the longest and straightest fiord along the coast of Alaska and British Columbia (McLain, 1969). The canal occupies a deep U-shaped valley with steep walls rising 1,000 to 1,500 meters above the floor. Lynn Canal extends for 150 kilometers, including the inlets at the head of the canal, and has a maximum width of 20 kilometers (McLain, 1969). The canal floor is relatively flat at a depth of 200 to 300 meters through much of its central basin. Near its mouth, the canal narrows and deepens to 500 to 700 meters.

Oceanographic field surveys were conducted for the Kensington Project in 1988 and 1989 in Lynn Canal (Dames & Moore, 1988 and 1990b; Rescan, 1990). The purpose of those surveys

was to determine distributional and seasonal patterns in the chemical and physical properties of waters in Lynn Canal near the proposed project. Studies also were conducted on the chemical composition, physical properties, and bathymetry (depth) of the sea bottom. A seismic survey was completed to document sea floor conditions in Lynn Canal near the project area.

A number of current meter moorings and sedimentation traps were also deployed. Grab samples of the sea bottom within the study area were analyzed to determine particle size at the interface between the water and sea floor sediments. Sample sites established for these studies are plotted on *Figure 3-14, Lynn Canal Oceanographic Sample Sites.*

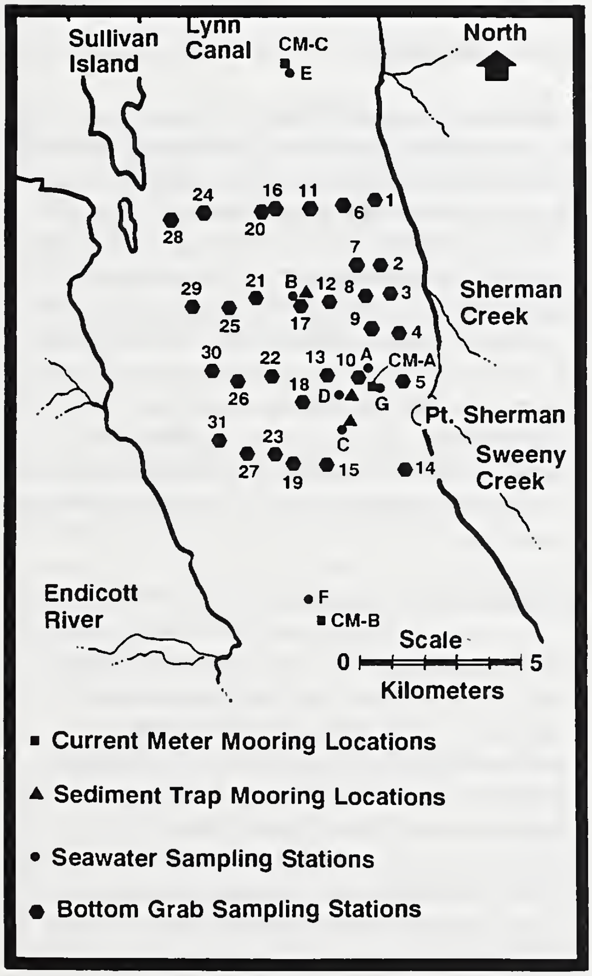


Figure 3-14, Lynn Canal Oceanographic Sample Sites

Water Column Structure

During summer, temperature and salinity gradients within the Lynn Canal water column act in concert to create a strong density gradient between the surface and deeper water (McLain, 1969; Rescan, 1990). Stratification along this density gradient was observed in the vicinity of the project site in September, 1988 (Rescan, 1990). The surface layer exhibited relatively low salinity (15 ppt) with a temperature of 11° C; below about 75 meters, salinity and temperature were relatively constant at 32 ppt and 5.5° C, respectively (Rescan, 1991). Stratification is much reduced in winter, as indicated by April 1989 data (Rescan, 1991). By June, 1989, stratification along these gradients was again strongly evident. Identical patterns were described by McLain (1969) for other locations in Lynn Canal.

Circulation Patterns

The circulation patterns of Lynn Canal are the result of a variety of factors including freshwater input, tidal exchange, winds, seawater density distribution, the earth's rotation (Coriolis), and bathymetric and topographic features (McLain, 1969; Rescan, 1991). While the relative influence of each of these varies both temporally and spatially within the canal, the dominant forces are freshwater input, tides, and winds (McLain, 1969; Rescan, 1991).

Because of freshwater input, Lynn Canal exhibits a classical estuarine circulation pattern: a general seaward movement of a surface freshened layer and a landward movement of deeper, more saline layers (McLain, 1969; Rescan, 1991). A large input of freshwater occurs into the canal from various rivers and streams together with precipitation.

This freshwater input, which remains associated with the surface layer, also is a major factor producing stratification in the canal (McLain, 1969). This results in a general seaward movement of a fresh or brackish surface layer being forced along by the hydraulic head of more freshwater entering behind it. Seawater, which is entrained upwards into the surface layer from below, is moved seaward also. To balance this flow, a headward replacement flow of seawater occurs at a deeper level, generally

creating a two layered circulation pattern within the canal (McLain, 1969; Rescan, 1991).

Estuarine circulation is greatest during summer and fall when freshwater input is at its highest level but minimal during winter when freshwater input is at its lowest level (McLain, 1969). Because of the lack of freshwater input during winter, tidal exchange and winds are the dominant forces creating circulation during that season (McLain, 1969).

Tidal flows are oscillatory, last about 12.4 hours, and are present throughout the water column in Lynn Canal (McLain, 1969). Tidal amplitudes range up to 6 meters near the project site (Rescan, 1991). McLain (1969), citing the U.S. Coast and Geodetic Survey (1967) and Woodworth and Haight (1927), noted that maximum southward-flowing ebb (outgoing) currents were greater than northward-flowing flood (incoming) currents in Lynn Canal, resulting in a net southerly set of the surface current. He attributed this to freshwater runoff.

Wind driven currents within Lynn Canal are variable and exist primarily within the surface layer (McLain, 1969; Rescan, 1991). The regional winds are typically southerly to southeasterly and are generated by dominant low pressure off the Prince of Wales Island/Queen Charlotte Islands region (ADF&G, 1979). These winds typically range from 5 to 35 knots and, when strong enough, alter southward surface flow. During winter, a large pressure gradient can exist over the length of the canal, creating extremely strong winds, known locally as Taku winds, which blow through the mountain passes and down the canal. These winds can exceed 100 knots.

These dominant factors affecting circulation are the main determinants of the flushing rate of Lynn Canal on the whole; the other factors can modify flows at specific locations within the canal. Based on an extensive data set of currents collected at different depths in the canal, Kessler and Vigers (1991) estimated the residence time of water for the entire Lynn Canal north of Point Sherman to be about 12 to 20 days. These values represent conservative estimates of the average amount of time required to flush upper Lynn Canal.

Circulation can be modified by the combination of factors interacting in specific areas within the canal. For example, topographic features along the shorelines can modify the prevalent flow patterns at specific sites, such as the eddy-like condition that appears to occur north of Point Sherman. In this case, the eddy-like circulation that can occur would be controlled largely by the tide with perhaps secondary influences from the internal tidal circulation and associated seasonal effects. None of these factors is consistent with a re-circulating retention feature that could remain in place for days at a time off Point Sherman (Kessler and Vigers, 1991) Such a condition could only occur under certain conditions that are in large part seasonal. When these conditions occur the re-circulation feature would be regulated by the tide and therefore would be highly variable over short time periods, i.e. minutes (Kessler and Vigers, 1991).

Current Velocities

Current velocities were measured near the project site from September 1988 to June 1989 using current meters deployed at depths between 24 and 260 meters (Rescan, 1990). Average velocities at 50 to 60 meters ranged from 11.5 centimeters per second in an up canal direction and 10 centimeters per second in a down canal direction to 2 to 8 centimeters per second in cross channel directions (Rescan, 1991). The highest 10 percent of the measured velocities ranged from 28 centimeters per second in both up and down canal directions to 6 to 16 centimeters per second in cross channel directions.

Bottom Characteristics Near the Project Site

The physical features of the submarine slope near the Kensington Project site are complex. (See *Figure 3-15, Lynn Canal Bathymetric Contours Near Point Sherman*). The northern portion of this area is broader and has less variation in relief than the southern portion. Based on echo-soundings, the nearshore areas appear to include rock outcrops, ledges and slopes, especially in the gullied areas (Dames & Moore, 1988).

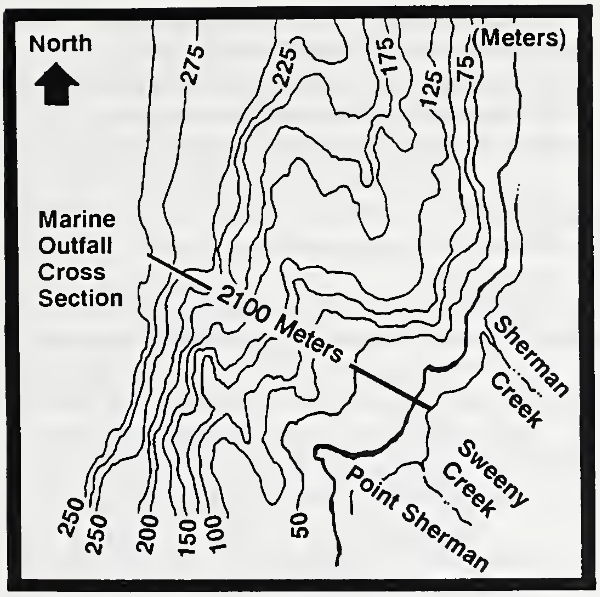


Figure 3-15, Lynn Canal Bathymetric Contours Near Point Sherman

Suspended Sediment and Deposition

Total suspended solids (TSS) were measured at seven stations and seven depths on three occasions near Point Sherman (September, 1988; April, 1989; and June, 1989; see Rescan, 1990). The data were pooled following statistical analyses that showed no significant dependence of measured TSS on station, depth or sampling time (Kessler and Vigers, 1991).

Sediment traps to measure naturally occurring particle deposition rates were deployed, typically for two months at a time, at three depths and three locations off Point Sherman between September 1988 and April 1989 (see Rescan Environmental Services, Ltd., 1990). The settled material recovered from the traps was analyzed for dry weight, volatile and non-volatile fractions, as well as heavy metal concentrations (Kessler and Vigers, 1991).

The mean annual TSS deposition rate was estimated at 897 grams/meter^2, (*See Table 3-6, Annual Background Particle Deposition in Lynn Canal*). Estimates are also provided of deposition rates for various heavy metals.

Bottom sediment samples were collected at 31 locations near Point Sherman on two occasions (i.e., September 1988 and June 1989) for a total of 62 sediment samples (see Rescan, 1990). Samples were analyzed for total arsenic, cadmium, cobalt, iron, lead, manganese, nickel, silver, zinc and mercury. Results presented in Kessler and Vigers (1991) showed spatially uniform sediment heavy metals, with concentrations ranging from 6 to 9 mg/kg for arsenic, 38 to 44 mg/kg for copper, 10 to 14 mg/kg for lead, 600 to 1,800 mg/kg for manganese, 32 to 46 mg/kg for nickel, 100 to 150 mg/kg for zinc and 40 to 90 ug/kg for mercury. There was a slight trend towards increasing concentration with depth for some metals.

Cadmium and silver concentrations in the Lynn Canal seabed sediment samples were generally below the mutual detection limit of 0.025 mg/kg, though cadmium concentrations as high as 1.1 mg/kg and silver concentrations as high as 0.7 mg/kg were measured on occasion (Kessler and Vigers, 1991).

Chemical Characterization of Water Quality

Seawater analyses were conducted to determine water chemistry within the water column at the oceanographic sampling sites. Chemical parameters measured were dissolved heavy metals: arsenic, cadmium, cobalt, copper, iron, lead, manganese, mercury, nickel and zinc. Dissolved metal concentrations in seawater typical of open waters of Lynn Canal are expected to be within 95 percent of recoverable metal levels, the standard employed by the EPA for water quality criteria (Pelletier, 1991).

Samples were collected at depths of approximately 50 meter intervals. from the surface to the bottom. Results of heavy metal analyses obtained at two sample stations (A and E) nearest the project site are contained in *DEIS Appendix Table D3-1, Chemical Characterization of Seawater, Station A* and *DEIS Appendix Table D3-1, Chemical Characterization of Seawater, Station E.*

MARINE BIOTA

Lynn Canal and its adjoining bays, including Berners Bay, support an abundant and diverse biota. Marine and anadromous species are present. These are described in the following sections:

- Intertidal Benthic Communities
- Subtidal Benthic Communities
- Crab and Shrimp
- Marine Fish
- Anadromous Fish

Point Sherman being the most prominent. The beaches between Point Sherman and Independence Creek to the north , a distance of 5 kilometers, are moderately sloped. This feature results in the first substantial intertidal and shallow subtidal habitat along the east side of Lynn Canal south of Chilkoot Inlet. Chilkoot Inlet joins with Chilkat Inlet 27 kilometers north of Point Sherman to form the main Lynn Canal. Rocky cliffs dominate the shoreline north of Independence Creek. The shoreline south of Point Sherman, extending to Point St. Mary at the opening to Berners Bay, is similar to that between Point Sherman and Independence Creek, except the beaches are composed of smaller gravel/cobble substrate (Archipelago, 1991).

Table 3-6, Annual Background Particle Deposition in Lynn Canal

Parameter	Mean (gm/m^2)	Lower Limit (gm/m^2)	Upper Limit (gm/m^2)
Total Arsenic	0.007	0.002	0.016
Total Cadmium	0.005	0.0008	0.024
Total Cobalt	0.018	0.005	0.051
Total Copper	0.041	0.011	0.114
Total Iron	40	10	98
Total Lead	0.015	0.003	0.044
Total Manganese	0.720	0.178	2.0
Total Mercury	0.0002	0.00002	0.001
Total Nickel	0.035	0.010	0.086
Total Silver	0.0001	0.00004	0.0003
Total Zinc	0.471	0.090	1.7
Total Solids	897	276	2,036

Intertidal Benthic Communities

The intertidal benthic (bottom dwelling) communities of shore reaches near Sherman and Sweeny creeks, as well as in Slate Creek Cove within Berners Bay, are described in Dames & Moore (1988b), JMM (1991), and Archipelago (1991). General descriptions of the intertidal flora and fauna of Lynn Canal and Berners Bay are also reported in Smith (1972), Calvin (1976), and National Marine Fisheries Service (NMFS, 1974). Intertidal surveys of the beaches in the vicinity of Sherman and Sweeny creeks were conducted in April, 1988 during periods of low tide (Dames & Moore, 1988b). Additional observations were made in May, 1991 (Archipelago, 1991).

The intertidal zone on the east shore of Lynn Canal near the project site consists primarily of cobble beach interrupted by rock outcrops, with

In general, the upper intertidal epifauna (organisms living on firm substrates) on the cobbles is dominated by marine snails (*Littorina sitkana*). Acorn barnacles (*Balanus glandula*) are sparse in the upper intertidal but more abundant in mid to lower intertidal. The blue mussel (*Mytilus edulis*) predominates at lower intertidal elevations. Some small patches of

rock weed (*Fucus distichus*) occur on cobbles at lower elevations; however, it is sparsely developed and covers less than 10 percent of the surface area where present. Under rock fauna is relatively sparse and includes blennies, green sea urchins (*Stronglocentrotus drobachiensis*), and marine worms (*Nemertenas* spp.).

The attached epifauna is relatively less dense on the cobble substrates compared to the rock outcrops. This is probably due to wave action. The stretch of beach near Sherman and Sweeny Creek is exposed to storm generated waves from the north. There is probably considerable movement of cobbles during storm events which could dislodge or crush attached organisms. The rock outcrops in the area provide a more stable platform for epifauna to withstand wave activity.

The epifauna on the rock outcrops, including Point Sherman, is dominated by an abundance of blue mussels and rockweed. Much of these areas have nearly a 100 percent cover of these organisms (Dames & Moore, 1988b). Acorn barnacles and marine snails are present on these outcrops at higher elevations. Small tidepools occur on the outcrops and support coralline algae, anemones (*Anthopleura* spp.), blennies, and sculpins (Dames & Moore, 1988b).

An assessment of habitat and biota of the intertidal zone of Slate Creek Cove within Berners Bay was performed in March, 1991 (JMM, 1991). Slate Creek Cove is a small bay on the northwest side of Berners Bay.

Subtidal Benthic Communities

Subtidal benthic communities in the vicinity of the proposed project are described in Dames & Moore (1988b, 1990, 1991). Additional observations are provided in Archipelago, (1991). These assessments were made as part of the environmental studies for the proposed project. Information on the subtidal benthic flora and fauna of Lynn Canal and Berners Bay is also found in University of Alaska (1969), Myren (1972), NMFS (1974), Parks and Zenger (1978), and Carlson et al. (1982).

The subtidal habitats near Sherman and Sweeny creeks were surveyed to a depth of 12 meters using scuba gear in April, 1989 (Dames & Moore, 1988b). Both horizontal (along a continuous depth contour) and vertical (from shallower to deeper water) transects were employed.

Species present were found to be relatively similar along all transects surveyed. The dominant organism was green sea urchin. Hermit crabs (*Pagurus* spp.), starfishes (*Pycnopodia helianthoides*, *Leptasterias hexactis* and *Solaster* spp.) and polychaete worms were also fairly common. Observations revealed no kelp in the upper subtidal habitat along the beach near Sherman Creek, but it was found along a narrow band between Sweeny Creek and Point Sherman (Archipelago, 1991).

Much of the shallow subtidal substrate at depths of 2 to 10 meters is similar in composition to the intertidal zone in this area, being comprised mainly of small cobbles and rocks. Below 10 meters in depth, the substrate is gradually replaced by a soft bottom (Dames & Moore, 1988b), though it is interspersed with steep slopes of rock outcrops and ledges until reaching the relatively flat, fine sediment covered canal floor (Dames & Moore, 1988a).

The infauna (organisms living in and on soft bottoms) in the vicinity of Sweeny and Sherman creeks were sampled in August, 1988 and April, 1989 (Dames & Moore, 1990 and 1991). Samples were obtained at a depth of 15 meters. Substrates at the sample sites consisted of fine silts, coarse sand, and gravel. In general, polychaete worms were the most dominant in numbers and biomass, with molluscs being the second most dominant group.

A total of 76 taxa was identified from three samples taken near Sweeny Creek, while 126 taxa were found in three samples obtained near Sherman Creek. Sample contents are detailed in Dames & Moore (1990 and 1991).

On the basis of the low densities and biomass found for the infauna, Dames & Moore (1991) concluded that these areas were impoverished and suggested that this habitat is relatively unstable. The data also show a high degree of

variability between samples and between sites, typical of benthic invertebrate populations in general (Elliott, 1977).

Crab and Shrimp

Lynn Canal and Berners Bay support a variety of crustacean shellfish. Principal crab species include Tanner (*Chionoecetes bairdi*), Dungeness (*Cancer magister*), and brown, blue, and red king crab (*Paralithodes* spp.). Shrimp species include pink (*Pandalus borealis*), spot (*P. platyceros*), humpy (*P. goniurus*), coonstripe (*P. danae*), sidestripe (*Pandalopsis dispar*), and crangon shrimp (*Crangon* spp.). Information on the presence, abundance, and condition of these resources is found in a variety of sources.

Much of the exploratory shellfish sampling in Lynn Canal and adjoining bays has been conducted by the NMFS. Species assessment cruises were carried out in several locations of these waters in 1951, 1962, 1970, 1975, and 1976 (NMFS, 1974; Parks and Zenger, 1978; Carlson et al., 1982). Tanner crabs were consistently the most abundant species encountered, regardless of location. Dungeness and king crabs were captured in much less abundance. Of the shrimps, pink and sidestripe were the most common species, both in Berners Bay and near Sullivan Island. Coonstripe shrimp were generally found in trace amounts.

Berners Bay is noted as supporting abundant crustacean populations. Myren (1972) observed abundant crab and shrimp in this bay near Echo Cove. Using scuba surveys, molting and mating Tanner crabs were observed, along with several hundred maturing female king crabs and numerous Dungeness crabs. Myren (1972) also reported that the entrance to Echo Cove in Berners Bay appeared very productive with abundant populations of juvenile pink and humpy shrimp.

NMFS (1974) found that Tanner crabs were the most abundant crab species encountered in Berners Bay in assessment work conducted in spring, summer and fall of 1970. Carlson et al. (1982) reported that small catches of Tanner crabs and pink shrimp were taken while bottom trawling in Slate Creek Cove on the northwest side of Berners Bay.

As part of the assessment work for the Kensington Project, traps was deployed on several occasions in the Point Sherman area to sample crustaceans in the area. In April, 1988, three shrimp pots and two crab pots were set in locations ranging between 10 to 50 meters in depth (Dames & Moore, 1988b). The crab pots were placed in an area where a few small red king crabs and Tanner crabs were observed during scuba surveys (*See previous section, Subtidal Benthic Communities*). A variety of bottom fish, invertebrates, and a few small Tanner crabs were collected in the shrimp pots, but no shrimp were caught. The only species collected by the crab pots were seastars, decorator crabs (*Oregonia* sp.), and green urchins. These species were typical of the epifauna observed during scuba surveys.

In October, 1988, 10 commercial Tanner crab pots were set in areas directly out from Sweeny and Sherman creeks, toward mid channel out from Point Sherman, and to the south of Point Sherman (Dames & Moore, 1991). The pots were deployed at depths ranging between about 65 to 300 meters. Besides several miscellaneous species of invertebrates, a total of one brown king crab and one Tanner crab was captured.

In April, 1989, 20 commercial Tanner crab pots were deployed at similar sites as those set during the previous October (Dames & Moore, 1990). Depths of fishing ranged between 65 to 300 meters. A total of 19 Tanner crabs were collected. Most of these were suffering from a blood parasite infection.

The first known isolation of the pathogen causing this disease, a dinoflagellate, was made in Lynn Canal (Meyers et al., 1987). Prior to the infestation of this organism, the abundance of Tanner crabs in Lynn Canal supported a significant fishery. However, the harvest of marketable Tanner crabs has declined dramatically over the past five years in Lynn Canal due to the spread of this pathogen in the population. This single-celled blood parasite invades all of the host's tissues. The infection produces an astringent after-taste in the cooked meat. The disease is eventually fatal to its host (Meyers et al., 1987).

Intensive sampling by ADF&G during the 1988 and 1989 seasons in Lynn Canal and throughout Southeast Alaska showed the highest levels of infestation in upper Lynn Canal, beginning at Sullivan Island and extending northward to Skagway (Meyers et al., 1990). Over 90 percent of the Tanner crabs were infected near Sullivan Island. As a result, the crab fishery of Lynn Canal is being severely impacted. Harvest of healthy crabs has declined to less than 25 percent of levels in the early 1980s, jeopardizing the marketability of crabs coming from this area (Koeneman, 1990).

Nearly all of the crab and shrimp species found in Lynn Canal are known to have substantial movements or migrations. Studies of movement conducted elsewhere can be generally applied to the Lynn Canal populations because such patterns are commonly accepted as being characteristic of these species.

Tanner crabs are not noted as having extensive migrations per se, but do exhibit substantial movements nonetheless. Donaldson (1980) described the movements of Tanner crab, based on extensive tagging, near Kodiak Island. The average movement per individual was 24.1 kilometers over the length of the study. Though the period of freedom of tagged crabs varied between one month and nearly four years, no correlation between time and distance traveled was evident. Males located in bay areas gradually moved offshore as they matured. Offshore crabs matured and remained in offshore areas, moving randomly within a defined geographic area.

Some Dungeness crabs have been found to exhibit migration patterns (Davis, 1981; Stevens and Armstrong, 1984), while others are believed to remain relatively local (Butler, 1957; Gotshall, 1978). Regardless of the extent of directional migration, this species characteristically exhibits substantial movement. Smith and Jamieson (1991), using several monitoring techniques in waters of British Columbia, found that individuals traveled an average distance of about 300 meters per day. Movement appeared to be random.

King crabs in Alaskan waters have been found to typically have extensive migrations during their life cycle (Powell, 1964; McMullen, 1967). Both juvenile and adult life forms exhibit substantial movement (Powell and Reynolds, 1965).

Most of the shrimp species found in Lynn Canal are also known to exhibit some type of movement. The two most abundant species, pink and sidestripe, have planktonic or pelagic larval forms, which typically disperse the young away from the breeding grounds (Butler, 1980). Many shrimp species, including pink and spot, exhibit a diel (one night and day period) vertical migration (Butler, 1980; 1991). Barr and McBride (1967) demonstrated the extent of this vertical movement for pink shrimp in waters of southeast Alaska. In their study, individuals moved off the bottom in the early evening (1800-2100), occupied the whole water column (above 90 meters) for most of the night, were most abundant in the upper layers (surface to 15 meters) after midnight for about 3 hours, and returned to the bottom in the early morning (0300-0600). There is also evidence that shrimp congregate or move in response to certain environmental factors, such as water temperature, salinity, or water density (Jensen, 1981; Butler, 1991).

One shrimp species in Lynn Canal, coonstripe, exhibits less movement than the other species. The five larval stages of this species remain near the place of hatching, at 18-54 meters, approaching bottom as development progresses (Butler, 1980). A diel vertical migration has not been reported for this species. Apparently, its entire life is spent within a single geographic area (Butler, 1991), though circumstantial evidence still suggests movement within this vicinity (Butler, 1980). This species has not been found in high densities within Lynn Canal.

Marine Fish

Numerous marine species inhabit Lynn Canal and Berners Bay. The major ones include Pacific herring (*Clupea harengus pallasi*), Pacific cod (*Gadus macrocephalus*), sablefish (or black cod, *Anoplopoma fimbria*), Pacific halibut (*Hippoglossus stenolepis*), arrowtooth flounder (*Atheresthes stomias*), flathead sole (*Hippoglossoides elassodon*), and skate species (*Raja* spp.). Species of lesser abundance include walleye pollock (*Theragra*

chalcogramma), starry flounder (*Platicthys stellatus*), rock sole (*Lepidopsetta bilineata*), yellowfin sole (*Limanda aspera*), rex sole (*Glyptocephalus zachirus*), Dover sole (*Microstomus pacificus*), rockfish species (*Sebastes* sp.), eulachon (*Thaleichthys pacificus*), and capelin (*Mallotus villosus*) (NMFS, 1974; Parks and Zenger, 1978; Carlson et al., 1982; Dames and Moore, 1988).

A generalized distribution of the major fish species, including shellfish, in the project area is given in *Figure 3-16, Generalized Summer Distribution of Major Pelagic Fish Within Lynn Canal*, and *Figure 3-17, Generalized Summer Distribution of Major Bottom Species Within Lynn Canal*. These figures show the eastern

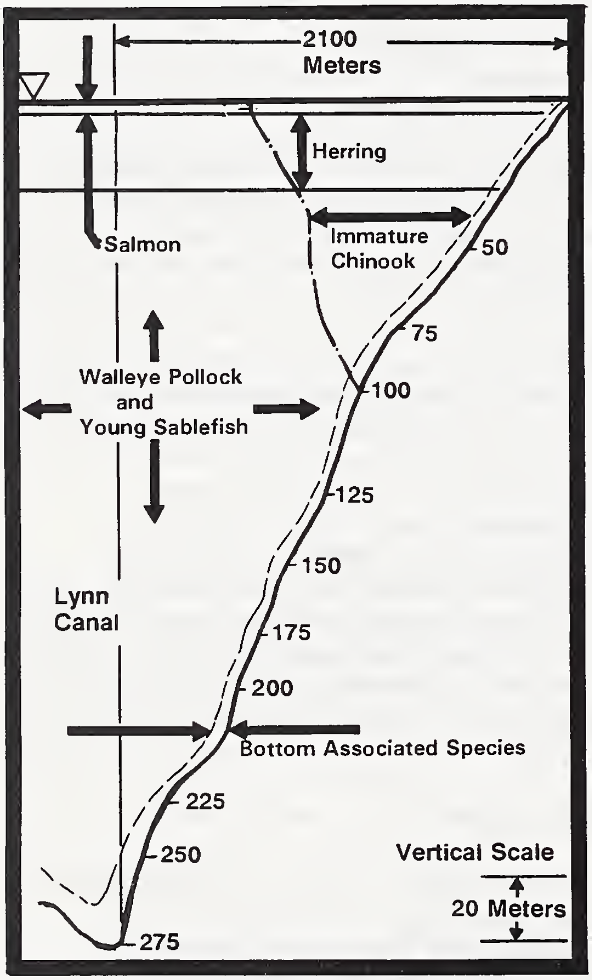


Figure 3-16, Generalized Summer Distribution of Major Pelagic Fish Within Lynn Canal

portion of a cross section of the canal at the proposed marine outfall. Generalized distributions for each of the major Lynn Canal species are shown as they normally occur during summer. Periodic deviations (such as brief feeding forays into the upper water column by bottom fish) are known to occur from these general patterns for some species. Also, distributions of some of the species shown (e.g., herring and halibut) vary seasonally.

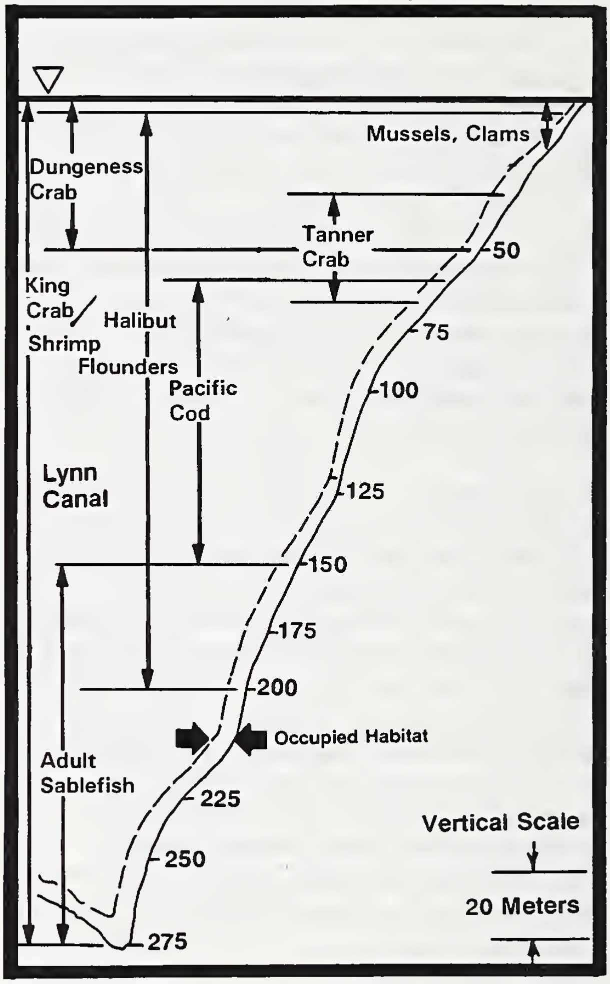


Figure 3-17, Generalized Summer Distribution of Major Bottom Species Within Lynn Canal

Pacific Herring. Pacific herring are known to spawn primarily in two general areas of Lynn Canal. These areas are surveyed annually by ADF&G. Spawning occurs between late April and mid May (Carlson, 1980).

The most heavily used area occurs along the south side of Berners Bay and south along the east shore of Lynn Canal. On several occasions, however, spawning has been observed to extend 1 to 2 miles north of Berners Bay, between Point St. James and Point Sherman. The second principal area,

utilized by fewer spawners, occurs near the head of Lynn Canal on the west side of Chilkoot Inlet (Ingledue, 1990).

In early May, 1991, a relatively small amount of spawning activity was observed at the mouth of Sweeny Creek (Archipelago, 1991). A school of mature herring was first observed along the shoreline in this area on May 2 and was observed actively spawning on May 3. Spawning ceased on May 4. The spawn was observed distributed along 180 meters of shoreline at the mouth of the creek, extending over an area of about 4,000 square meters. The biologist who made these observations considered the activity small and localized in extent as no other herring schools or spawn were observed in the general area (Archipelago, 1991).

Herring do not overwinter in either Berners Bay or upper Lynn Canal (Carlson, 1980). During summer, schooled herring are known to feed throughout Lynn Canal (Ingledue, 1990). This species represents an important food source for salmon, sea lions, seals, and some species of seabirds and whales. Concentrations of animals preying on herring often occur in areas where herring school to feed or spawn.

Groundfish. Based on commercial catch statistics, the three most abundant species of groundfish (fish residing primarily on or near the bottom) in Lynn Canal in recent years are halibut, Pacific cod, and sablefish (ADF&G Preliminary In Season Commercial Harvest Records, 1987-1990, Peltonan, 1991). Halibut and sablefish are the predominant species in lower Lynn Canal (i.e. south of Saint James Bay). Pacific cod are more abundant within the middle and upper reaches of Lynn Canal (Bracken, 1990).

Halibut are known to have extensive migrations throughout the northeast Pacific Ocean. Besides migrating large distances during their lifetime, which is long compared to other species, halibut also show a strong seasonal preference for different habitats within a general area. During summer, depths extending from the beach to about 200 meters are preferred, while deeper water is sought during winter (Bracken, 1990; Klausen, 1991).

Adult sablefish use lower Lynn Canal for summer feeding, though this area is apparently on the fringe of their more heavily used feeding grounds in Chatham Strait (Bracken, 1990). Commercial fisheries occur in these areas for sablefish, with little harvest occurring north of Admiralty Island (Bracken, 1990). Young sablefish (ages 1-3) are known to rear in estuarine areas around Lynn Canal (including Berners Bay and Echo Cove), especially when there are strong year classes. Young fish are often associated with estuarine areas before moving, as they mature, to deeper water and eventually to the Gulf of Alaska. Older fish return to the inside waters for summer feeding (Bracken, 1990). Spawning occurs elsewhere, primarily in the eastern portions of the Gulf of Alaska (Bracken, 1982).

The largest concentration of Pacific cod in Lynn Canal is believed to occur near Sullivan Island, where a fishery has been concentrated in recent years (Bracken, 1990).

The relative abundance of groundfish species in Lynn Canal can vary significantly. For example, walleye pollock were very abundant in the 1970s, possibly the most abundant groundfish species at that time (Bracken, 1990). This species was numerous throughout the region during those years, then declined sharply in the 1980s. Causes of the reduction have been suggested to be unfavorable conditions for recruitment of young fish to inside waters from the Gulf of Alaska and losses due to disease (Bracken, 1990). Such natural fluctuations in groundfish relative abundance are not uncommon to the northeastern Pacific region, including waters of Southeast Alaska (Alverson et al., 1964).

As part of the assessment work for the Kensington Project, longlines were set on two occasions in the vicinity of Point Sherman to help assess species composition in that area (Dames & Moore, 1990 and 1991). The work was conducted October 10-11, 1988 and April 15-16, 1989. On each occasion, three standard commercial longlines were deployed, with each approximately 2 kilometers (1.25 miles) in length. Each longline contained between 315 to 335 hooks.

The longline sets were made south of Point Sherman, directly west of the point near mid channel, and north of the point and directly out from Sweeny and Sherman creeks. Water depths ranged between 55 and 300 meters (see Dames & Moore, 1990 and 1991, for details). Catches in October were dominated by sablefish. The next most dominate species was halibut, which were taken roughly in equal numbers in all sets. Other species included arrowtooth flounder, walleye pollock, Pacific cod, an unidentified skate, redbanded rockfish (*Sebastes babcocki*), and yellowmouth rockfish (*S. reedi*). In April, 1989, catches were dominated by arrowtooth flounder, followed by halibut. Other species included sablefish, Pacific cod, and a skate.

Trawl surveys have been conducted by NMFS in Lynn Canal and its adjoining bays on several occasions in the past. Sampling was conducted in Slate Creek Cove in Berners Bay, St. James Bay, and on the west side of Sullivan Island in 1975 and again in St. James Bay in 1978 (Carlson et al., 1982). The Slate Creek Cove sample was dominated by starry flounder. Walleye pollock juveniles and adults were also numerous. One halibut was captured along with flathead sole, yellowfin sole, arrowtooth flounder, rex sole, and rock sole. Other species included juvenile sablefish, juvenile herring, eulachon (*Thaleichthys pacificus*), several species of pricklebacks (*Stichaeidae*), and sculpins (*Cottidae*).

The prevalent species caught in trawl surveys in Lynn Canal in 1976 by NMFS were (in order of abundance) walleye pollock, skates, flathead sole, Tanner crab, Pacific cod, and arrowtooth flounder (Parks and Zenger, 1978). Since the trawl surveys of the 1970s, the abundance of adult walleye pollock has declined sharply, as previously noted.

Larval Forms and Miscellaneous Species. The composition and timing of larval marine species in the project vicinity can be inferred from recent research at Auke Bay (Haldorson et al., 1990). Sampling was conducted from mid-March through mid-June during 1986 to 1989 in Auke Bay. The dominant larval fish were walleye pollock, flathead sole, eulachon, Pacific sandlance (*Ammodytes hexapterus*), and rock sole. Mean densities of larvae of all species of walleye pollock and flathead sole occurred near the time of peak density of copepod nauplii, the main prey. Larval flathead sole were most numerous between depths of 5 to 10 meters during the day, while walleye pollock larvae were most numerous between 5 to 10 meters.

An older, but more site specific, description of the ichthyoplankton is available in Mattson and Wing (1978). Sampling in 1972 in Berners Bay and Lynn Canal near the proposed project site showed an abundance of walleye pollock, smelt species (*Osmeridae and Bathylagidae*), and a variety of other fish species. (*See Table 3-7, Larval Fish and Fish Eggs Caught in Berners Bay and Lynn Canal, 1972*). Peak densities of most species occurred in May and June.

Capelin, a species of smelt, are known to spawn in relatively small numbers along Berners Bay, though knowledge about this is limited (Ingledue, 1990).

Anadromous Fish

Anadromous fish are species that begin their lives in freshwater habitats, migrate to marine habitats where they mature, then return to freshwater to spawn. The most abundant anadromous species in Lynn Canal are Pacific salmon. All five species, native to North America, occur in these waters. These consist of the sockeye salmon (*Oncorhynchus nerka*), chum salmon (*O. keta*), pink salmon (*O. gorbuscha*), coho salmon (*O. kisutch*), and chinook salmon (*O. tshawytscha*). Other anadromous salmonid fishes utilizing these waters include Dolly Varden char (*Salvelinus malma*), cutthroat trout (*O. clarki*), and steelhead trout (*O. mykiss*) (NMFS, 1974; Celewycz, 1984).

One species of anadromous smelt, eulachon, also utilizes Lynn Canal waters.

Major Production Areas. The major production areas for salmonid species in Lynn Canal are the Chilkat and Chilkoot rivers at the head of the canal and the Berners River, which flows into Berners Bay. Other smaller streams and rivers entering Lynn Canal and Berners Bay produce some of these species as well, though at much lower levels.

Table 3-7, Larval Fish and Fish Eggs Caught in Berners Bay and Lynn Canal, 1972
(in larvae or eggs/10 m^2, caught with 61-cm diameter, 0.33 mm mesh bongo nets)

	Berners Bay						Mid Lynn Canal						Danger Point				
Species	May	Jun	Jul	Aug	Oct	Nov	May	Jun	Jul	Aug	Oct	Nov	May	Jun	Jul	Aug	Nov
Walleye Pollock	383	458	7	2	0	0	1,390	315	3	0	0	0	2,362	143	27	0	0
Blacksmelt	7	128	104	25	0	1	32	95	31	44	12	30	53	21	51	41	2
Eulachon	0	4	106	107	0	0	0	0	0	12	0	0	0	3	24	116	0
Other Smelt	0	105	0	0	5	0	0	48	64	0	0	0	0	0	358	0	0
Sculpin	24	0	3	0	0	0	3	21	6	0	0	7	9	1	10	0	0
Prickleback	15	12	0	0	0	0	10	6	0	0	0	0	18	11	0	0	0
N. Lampfish	0	0	0	0	1	0	0	9	0	15	27	13	0	0	0	0	0
Sandlance	28	3	0	0	0	0	0	15	0	0	0	0	2	0	0	0	0
Snailfish	3	3	3	5	0	0	0	3	0	0	0	0	7	6	5	1	0
Poacher	10	0	1	1	0	0	3	0	0	0	0	3	0	0	0	0	0
Rock Sole	4	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0
Misc. Founder	1	0	0	0	0	0	0	0	0	0	0	0	12	0	2	0	0
Eelpout	0	0	0	0	0	0	0	9	0	0	6	0	0	0	0	0	0
Rockfish	0	0	0	0	0	0	6	3	0	0	0	0	0	0	5	0	0
Flathead Sole	0	0	7	0	0	0	0	0	0	0	0	0	0	3	2	0	0
English Sole	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	1	0
Searcher	0	0	0	0	0	0	0	3	3	0	0	0	0	0	5	0	0
Sand Sole	0	3	0	3	0	0	0	0	0	0	0	0	0	3	0	0	0
Starry Flounder	20	0	0	5	0	0	0	0	0	0	0	0	0	0	0	1	0
Greenling	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2
Total[1]	478	717	232	147	7	1	1,445	527	107	70	45	53	2,464	191	512	162	5

Source: Mattson and Wing (1978)
Note: No samples were collected for September in all survey areas or for October at Danger Point.
[1]Totals may not add due to rounding.

Based on annual salmon harvest statistics, sockeye and chum are the most abundant salmon species in Lynn Canal, followed by chum, pink, then coho. Chinook are much less abundant than the other salmon species. Catch levels, which normally are a good reflection of overall abundance, show that salmon abundances fluctuate widely in the canal. Such fluctuations are typical of salmon populations (Lichatowich and Cramer, 1979).

The Chilkat and Chilkoot rivers are the largest single river producers of sockeye salmon in Southeast Alaska (Bergander, 1990). In the mid 1980s, between 400,000 to 600,000 adult sockeye returned to Lynn Canal each year (McPherson, 1987a; McPherson, 1987b; McPherson and Jones, 1987). The combined spawning escapement for these two rivers has ranged between approximately 55,000 and 145,000 for the past 20 years (Bergander, 1991). These two rivers are also major producers of chum and pink salmon.

The Berners River is ranked among the top producing coho rivers in Southeast Alaska (ADF&G, 1984). From 1982 to 1989, the estimated average run size of adult coho produced from Berners River (including all estimated catch) was approximately 23,000 fish (range 14,100 to 34,000) (Shaul, 1990a). Spawning escapements of 2,100 to 10,000 fish typically occur (Shaul, 1990b).

Current levels of chinook production in Lynn Canal rivers are low. Of the numerous rivers and streams entering the canal, including Berners Bay, the Chilkat has the only significant run of chinook. Spawning escapements in that river system for 1975 to 1990 have varied between approximately 200 to 2,000 fish, with no particular trend evident (Pahlke, 1991). The status of the stock for fishery management purposes is considered depressed; objectives to rebuild stock abundance are not being achieved (Pahlke et al., 1990). Harvest of the stock occurs in the Lynn Canal drift gillnet fishery, the Haines and Juneau areas marine recreational fisheries, and the commercial troll fishery in Icy Straits (Pahlke et al., 1990).

Not all chinook utilizing Lynn Canal waters originate in the Chilkat River. Recoveries of tagged salmon from Lynn Canal fisheries indicate that a significant portion, perhaps most, of the chinook caught in Lynn Canal originate in other areas, including other parts of Southeast Alaska, British Columbia, and Washington State (Pahlke et al., 1990). Many of the chinook within Lynn Canal are immature fish that are feeding.

The principal production streams for Dolly Varden within Lynn Canal are the Chilkat and Chilkoot rivers. These river systems provide major spawning and juvenile rearing areas, as well as the most important overwintering lakes in the Lynn Canal area (Ericksen et al., 1990; Ericksen and Marshall, 1991). Dolly Varden harvests by recreational fisheries in the Haines area have declined since 1986 and may be due to a decline in population numbers in the general area (Ericksen and Marshall, 1991).

Eulachon are known to spawn in various rivers draining into Lynn Canal, including those entering Berners Bay (NMFS, 1974; Ingledue, 1990). This species spawns in the lower reaches of rivers, moves quickly to estuarine or marine waters as larvae after hatching, then disperses throughout coastal waters where individuals mature over the next 2 years (Barraclough, 1964).

Juvenile Use of Marine Habitats. Lynn Canal and Berners Bay serve as both rearing areas and migration pathways for juvenile salmonid species. The annual relative abundance of the juvenile forms of these species is expected to correspond with that of the adult forms migrating through the same waters. In other words, sockeye and chum generally being the most abundant, followed by pink, coho, then the other species. Their use of these waters varies between species, both spatially and temporally, though chum and pink salmon exhibit many of the same patterns during their early marine lives.

Of the species present, most is known about pink and chum for this area, or as inferred from similar areas. Both species migrate rapidly from freshwater following their emergence from spawning gravels, which generally during late March to early May (Taylor et al., 1986; Thomason and Jones, 1985). In marine waters the fry of both species aggregate in the nearshore zone, often in water less than one

meter deep (Healey, 1980). Both species are often found together (Jaenicke et al., 1985).

In the Lynn Canal-Chatham Strait region, pink and chum fry are associated with the nearshore zone from about April 1 to mid June (Celewycz, 1984; Archipelago, 1991). Survival during this period is considered a critical determinant of the population's subsequent overall marine survival (Celewycz, 1984), suggesting a vital role of nearshore habitat in the life cycles of these species (Orsi and Landingham, 1985).

The use of nearshore habitat as both nursery grounds and a migration pathway for pink and chum fry has been well described for the Chatham Strait-Lynn Canal region. In general, shorelines interrupted by large boulders or other irregularities, such as reefs, which offer protection from waves and strong currents, are preferred milling and feeding areas (Jaenicke et al., 1985). Areas containing kelp beds are often used for milling (Mattson, 1990). Shorelines lacking any of these features appear to be used mainly as migration pathways (Bailey and Mattson, 1985).

As part of the assessment for the Kensington Project, a study was conducted in spring 1991 to investigate the movement of pink and chum fry along the shoreline between Point Sherman and Independence Creek to the north (Archipelago, 1991). Beach seining was used to capture fish along the shoreline between late April and mid May (*Figure 3-18, Juvenile Salmon Seining Locations*). Pink and chum fry captured at three locations were marked by freeze branding and released at the point of capture. A total of 127 seine sets were made, yielding catches of approximately 14,700 pink fry and 10,700 chum fry. Of these fish, a total of 6,078 pink were marked and released with 132 subsequent recaptures. A total of 3,510 chum were marked and released with 738 subsequent recaptures.

The study found that pink and chum fry were well distributed over the seining sites throughout the period of sampling. Small schools (10-200 fry) of both species occurred within 15 meters of the shoreline near the water surface. Marked pink and chum were recaptured moving both north and south along the shoreline within the study area; no preferred direction was found.

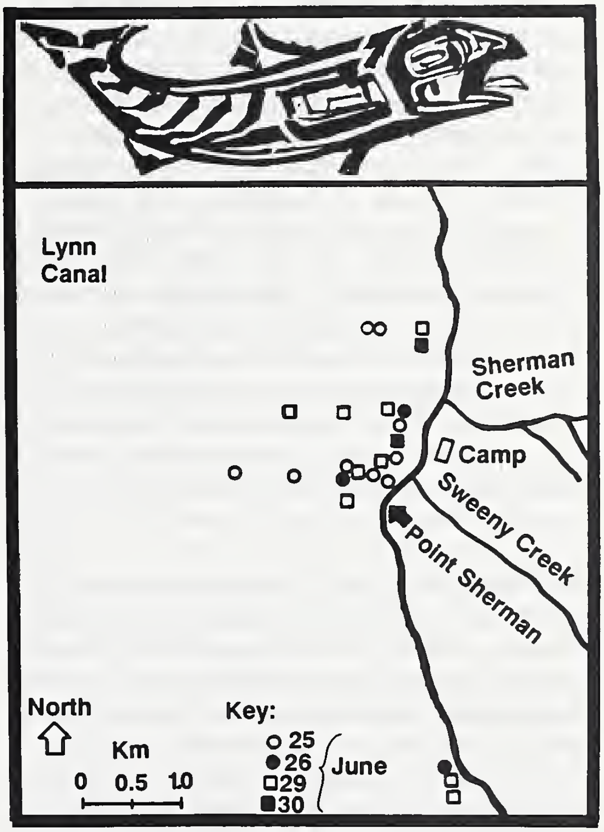


Figure 3-18, Juvenile Salmon Seining Locations

The estimated average nearshore residence times at the sites of release were longer for chum than pink, ranging between 0.5 to 7.2 days for chum and 0.5 to 3.2 days for pink.

Additional beach seining was conducted at these sites in late June, at which time purse seine sampling was also conducted using research gear in deeper waters in the Point Sherman vicinity (Archipelago, 1991). Very few pink and chum were found in either the nearshore zone or deeper off-shore areas, indicating that emigration from the general area was generally complete by that time.

These findings demonstrated that the shoreline between Point Sherman and Independence Creek is used for both rearing and migration of pink and chum fry. The beach to the south of Point Sherman would be expected to be used in similar manner, though it may have less rearing potential due to greater exposure to southwest winds.

The observed patterns of movement near the proposed project site appear to be similar to those described by Healy (1980) for pink and chum in the Strait of Georgia, B.C. As such, fry would disperse quickly away from their natal streams, rearing over a wide range of nearshore habitats. In the Kensington study, for example, the chum fry could not have been produced in the nearby creeks due to the lack of spawning there by that species (Pentec, 1990). These fry would likely have been produced either in the Berners River to the south, or the Chilkat or Chilkoot rivers to the north. The very low spawning escapement of chum (600) in the Berners River in 1990 suggests that these fry originated to the north; the escapement in the Chilkat was estimated to be about 70,000 spawners (Bergander, 1991).

Once the initial dispersal of pink and chum fry has occurred from natal streams, the nearshore habitats would be used opportunistically. The fry would remain along a particular stretch of shoreline until relocating in search of new habitat or they are moved non-volitionally by tide or current. Residence at any particular site would tend to be quite short. The fry would move off-shore in June, as immigration toward the Gulf of Alaska continues (Celewycz, 1984). Migration to the Gulf is believed to occur in July and August (Scott and Crossman, 1973).

Sockeye salmon smolts (ages 1 and 2) normally emigrate from the Chilkat and Chilkoot rivers after June 1, with peak migration typically occurring in late June (Bergander, 1990). Their migration pattern through Lynn Canal has not been documented but can be inferred from other studies of sockeye salmon.

Studies of sockeye salmon smolts in British Columbia have found their seaward migration through marine waters to be relatively rapid, associated primarily with surface waters, and widely distributed throughout the migratory waterbody (Groot and Cooke, 1987; Cooke and Groote, 1990). Movement was found to average 3 to 5 kilometers per day. Likewise, Straty (1974) reported that sockeye smolts migrated quickly through inner Bristol Bay, traveling in small scattered schools in the upper 2 meters of the water column. That study also found the migrants to be widely distributed over the migratory waterbody.

Jaenicke and Celewycz (in press) found indirect evidence for a rapid seaward movement of juvenile sockeye salmon in Southeast Alaska. They noted that sockeye salmon recently arrived from freshwater were more numerous in "outside" marine waters than in "inside" marine waters in July and August. They reported that their observations were consistent with the conclusions of Straty and Jaenicke (1984) and Healey (1982) that sockeye enter oceanic waters before either pink or chum salmon. Such a timing would require a relatively rapid transition from freshwater to outside marine waters.

As part of the assessment for the Kensington Project, sampling was conducted in upper Lynn Canal between June 25 to July 1, 1991 in an attempt to collect migrating sockeye salmon (Archipelago, 1991). The sampling was conducted at a time that normally would have been slightly past the peak of migration from the Chilkat and Chilkoot rivers. A research purse seine was used. Sampling occurred at 44 different sites; 24 in the vicinity of the proposed project and 20 on the eastern and western sides of upper Lynn Canal, between Point Sherman and Haines. Most sets were made within 200 meters of shore, usually near prominent rocky points. Aggregations of migrating sockeye juveniles are often found off prominent points (Cooke and Groote, 1990).

A total of seven sockeye smolts were captured during this period, all within the northwestern part of the survey area. Archipelago (1991) concluded that the smolt run may have been late in 1991, though the suggestion was also given that flood waters may have dispersed the run. Either possibility would likely have resulted in a rapid migration through Lynn Canal, consistent with the movement patterns observed elsewhere for sockeye.

Coho salmon juveniles emigrate from freshwater at ages of 1 to 4 years, with peak migration occurring after the peak of pink and chum emigration (Healey, 1982). They can be caught by beach seining in the Chatham Strait-Lynn Canal region in May (Celewycz, 1984; Archipelago, 1985). They remain associated with the nearshore environment through mid June (Celewycz, 1984). Coho smolts were the most common salmonid species captured by

purse seining in upper Lynn Canal during sampling in late June 1991 (Archipelago, 1991). Some of these fish originated in the Berners River, as shown by recaptures of tagged fish. Though some coho apparently move seaward toward the gulf during summer, many continue to utilize the inside waters of Southeast Alaska until fall (Jaenicke and Celewycz, in press).

The abundance of chinook juveniles in Lynn Canal is less than levels for the other salmon species. Little natural production of this species occurs from streams entering the canal. In contrast to the seasonal use of the inside waters of Southeast Alaska shown by the other salmon species, chinook salmon produced in the Chilkat River appear to reside for much or all of their lives in these waters. Based on tagging studies, Pahlke et al. (1990) reported that Chilkat River chinook appear to be harvested entirely on inside waters as both immature and adult fish.

As noted earlier, Lynn Canal, like other inside waters of Southeast Alaska, is a feeding grounds for immature chinook originating in areas removed from the immediate area. Some of these fish are produced in waters as distant as Washington State.

Dolly Varden, which inhabit many of the streams entering Lynn Canal, emigrate to marine waters after 2 to 4 years in their freshwater spawning stream (Armstrong, 1970). This movement occurs in late May or early June. After entering saltwater, Dolly Varden migrate along the nearshore zone, often staying within 6 meters of shore, but apparently exhibit no directional movement (Armstrong, 1974; Armstrong and Morrow, 1980). During their marine water residency period, Dolly Varden are known to travel extensively. For example, the furtherest documented recovery of a tagged Dolly Varden from Chilkat Lake is 202 kilometers (Ericksen and Marshall, 1991).

After residing in marine waters for 60 to 160 days, Dolly Varden are known to generally move into a lake-stream system to overwinter (Armstrong, 1965). After one or more subsequent movements to saltwater, the mature fish are believed to return to their natal stream of origin to spawn (Armstrong, 1974).

Archipelago (1991) caught substantial numbers of Dolly Varden while beach seining near the project site. Dolly Varden were also captured by purse seining during the late June sampling in upper Lynn Canal. One fish caught near Point Sherman had been tagged during its migration from Chilkat Lake.

Adult Migrations Through the Project Area. Based on the timing of the commercial harvest from 1985 to 1989, adult salmon return through upper Lynn Canal from mid-June to mid-October. There is considerable variability among the timing of the different species, however. Chinook return earliest in mid-May through July, followed by sockeye in July through early August. *(See Figure 3-19, Harvest of Pacific Salmon in Upper Lynn Canal)*. Pink salmon have both an early and late run. Chum and coho are the latest returns, with harvests continuing into early October. *(See Figure 3-19, Harvest of Pacific Salmon in Upper Lynn Canal)*. Entry into the rivers for spawning occurs soon after the movement through the fishing areas.

The movement of adult salmon through upper Lynn Canal appears to be primarily along the eastern shore. Fish entering the canal from the ocean move eastward across the canal near Little Island and continue up the east side to the spawning rivers (Ingledue, 1991). This behavior pattern is well-known among fishermen who set their nets predominantly along the eastern shore.

Commercial Fisheries

Lynn Canal supports major commercial fisheries, with salmon being the most notable. Other commercial fisheries in the canal occur for groundfish (principally halibut, Pacific cod, and sablefish), crabs, and shrimp. Herring and pollock were fished in past years but current stock sizes do not provide harvestable fish.

Salmon Fisheries. Lynn Canal has supported intensive salmon fisheries since before the turn of the century. The aggregate cannery pack in 1902 for canneries in upper Lynn canal exceeded 100,000 cases or over 1 million fish, most of which were sockeye salmon (NMFS, 1974).

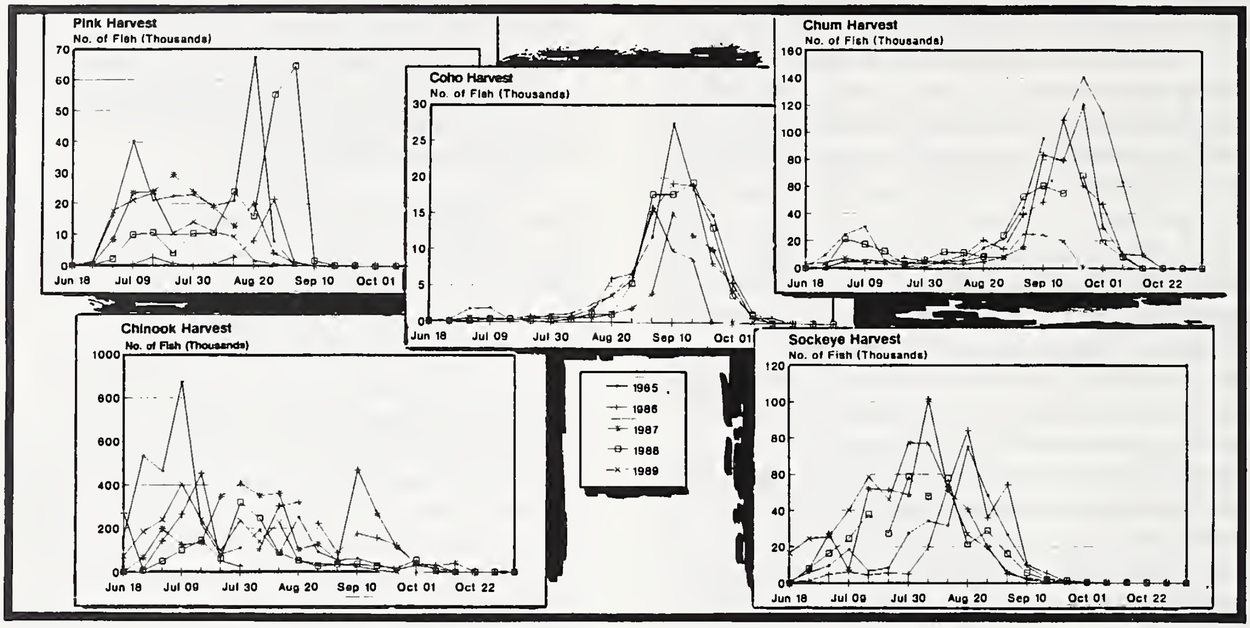


Figure 3-19, Harvest of Pacific Salmon in Upper Lynn Canal

The history of salmon fisheries for this area follows the pattern elsewhere in the state; very intensive fisheries gradually gave way to reduced fishing time as stock sizes declined. By 1973, the gillnet fishing season was reduced to one day per week until mid-June with three days per week thereafter (NMFS, 1974). Today, management involves opening and closing the fisheries to achieve target harvest rates on individual stocks passing through the canal (McPherson, 1987b). A typical season consists of 2 to 3 days per week from the third week in June through late August and 1 to 2 days per week thereafter, usually until early in mid October (Ingledue, 1991). Resulting catch patterns for the five salmon species are shown in *Figure 3-19, Harvest of Pacific Salmon in Upper Lynn Canal.*

The commercial salmon fisheries are currently restricted to drift gillnets, which may vary from 50 to 350 vessels during the season. Late summer and fall runs of salmon attract gillnetters to the area from throughout Southeast Alaska.

The commercial salmon fleet is highly effective at harvesting salmon in upper Lynn Canal. Harvest rates in this area are commonly in excess of 0.50, and sometimes as high as 0.70, or higher.

Much of the salmon fishing activity in upper Lynn Canal occurs near the project vicinity and is centered around Point Sherman. Point Sherman is at the east end of the commercial fishing boundary that extends across Lynn Canal and separates Fishing Areas 15A (to the north) and 15C (to the south). Fishing boats line up off Point Sherman so they can catch salmon as they cross the boundary on their northward migration up Lynn Canal. The area immediately off Point Sherman is most heavily fished along this boundary.

During the commercial openings, the number of boats fishing in the Point Sherman area ranges from a low of 20 to over 100. These boats generally range in size from 30 feet to 50 feet. The nets are 1,200 feet long and approximately 24 feet deep. The nets are typically set in a straight line perpendicular to the beach. Where water depth is sufficient to accommodate nets, fishing occurs in very close proximity to shore (Ingledue, 1991). There is no regulation that controls how close the nets are set to each other. The nets drift with the currents and are picked up every 20 to 90 minutes, depending

on the individual fisherman's operation. In addition to fishing activity, the area just to the north of Point Sherman is used as a protected anchorage from southerly winds for fishing boats and tenders.

In recent years, sockeye and chum salmon have dominated the harvest with pink salmon also comprising a significant portion of the catch. (*See Table 3-8, Commercial Salmon Harvests in Upper Lynn Canal, 1985-1989*). Sockeye dominate the harvest value because of the much greater value per pound.

than for halibut, though the catch is significantly less. The average annual catch (dressed weight) of the other major species from 1987 to 1990 in the area was; 25,000 lbs of Pacific cod, 3,200 lbs of sablefish, 1,200 lbs of rockfish, and 200 lbs of other species (ADF&G Preliminary In-Season Commercial Harvest Records, 1987-1990). The majority of the catch is taken near Sullivan Island (Bracken, 1990).

Crab and Shrimp Fisheries. Commercial fisheries for Tanner and king crab occur in Lynn Canal with the majority of activity near the project area occurring within and near the mouth of Berners Bay. Other bays and inlets around the canal also are primary fishing areas. Onsite observations and interviews with NMFS, ADF&G, and other agency personnel (Dames & Moore, 1988) indicate that little commercial crab fishing activity occurs in the project area north of Berners Bay. The fishery has suffered a significant decline in catch in recent years due to bitter crab disease.

Table 3-8, Commercial Salmon Harvests in Upper Lynn Canal, 1985-1989 (in numbers of fish)

Harvest Year	Chinook	Sockeye	Coho	Pink	Chum
1985	3,260	304,005	98,355	239,080	699,024
1986	2,772	289,889	82,121	38,115	381,382
1987	3,223	415,881	53,630	165,748	392,938
1988	1,257	351,876	81,537	208,423	377,768
1989	1,995	471,934	50,307	110,436	123,671

Herring Fisheries. A herring sac roe fishery took place in the Berners Bay area until 1983 when it was closed due to low stock size. The fishery was primarily conducted with purse seines (Blankenbeckler and Larson, 1987). The cause of the decline in stock size is believed to have been overfishing.

Groundfish Fisheries. Commercial fisheries for groundfish occur in Lynn Canal with catches principally comprised of halibut, Pacific cod, and sablefish. The harvest of halibut (in weight) is significantly greater than for the other species.

The halibut fisheries in this area occur simultaneously with halibut openings throughout Southeast Alaska. In recent years the fishery has consisted of between 1 to 3 open days per year. The annual catch within Lynn Canal is about 105,000 pounds with little variation from the average in recent years (Peltonan, 1991).

Fisheries targeted on the other groundfish species occur over a much longer time period

Relatively minor shrimp fisheries also take place in upper Lynn Canal. Catches tend to consist predominantly of spot shrimp. Fishing activity occurs along the steep eastern side of the upper canal, primarily during fall and winter months (Imamura, 1991).

FRESHWATER BIOTA

The two streams most directly associated with project alternatives are Sherman and Sweeny creeks. Another stream, Slate Creek, empties into Berners Bay near the docking facility associated with Alternative C. Initial

assessments of fish populations and habitat were provided in Buell (1989).

A more comprehensive assessment was made in Sherman and Sweeny creeks in summer 1991. That effort consisted of quantifying habitat characteristics, establishing a photographic record of stream conditions along each stream course, assessing rearing fish densities, installing continuous recording temperature monitors, assessing spawning gravel composition and sampling benthic invertebrate populations (Konopacky Environmental, in press). Most of these activities were designed to be a part of on-going monitoring. Preliminary summaries of results are incorporated herein where appropriate. Additional information on Sherman and Sweeny creeks is provided in Pentec (1990, 1991).

All three project area streams support anadromous and resident fish populations. Pink salmon is the predominant species, followed by Dolly Varden char (including both anadromous and resident forms). Small numbers of coho are present. Cutthroat and/or rainbow trout occur in Sherman and Sweeny creeks. Three-spine sticklebacks (*Gasterosteos aculeatus*) also are present.

Information on the aquatic resources of these streams is contained in the following sections:

- Description of Streams
- Habitat Capability Modeling
- Assessment of Rearing Populations
- Assessment of Spawner Abundances

Description of Streams

Sherman Creek. Sherman Creek flows into Lynn Canal over a cobble beach at Comet, north of Point Sherman, and drains a watershed of 4.09 square miles. The aspect of the watershed is west and the upper portions of the basin are steep, rising to peaks and permanent snow fields up to 5,500 feet in elevation.

The lower 1,200 feet of Sherman Creek (C5 and B7 Channel Types - See *Table 3-9, Channel Type and Geomorphoric Characteristics*) are moderately steep, about 4 percent gradient, with a bed composed primarily of large cobbles and small boulders. Woody debris is scarce and few pools exist. The percentages of water surface area contained in pools, riffle and glide in July 1991 were 8 percent, 77 percent and 15 percent respectively. Closely overhanging riparian vegetation is intermittent along both stream margins. Fish habitat for rearing species (i.e., coho, Dolly Varden and cutthroat) is generally poor because of the lack of pools. Pink salmon spawning habitat is limited because suitable spawning substrate deposits occurs

Table 3-9 Channel Type and Geomorphic Characteristics

Contained Channel Types	
A1	Very deeply incised, high gradient, mountain slope channel
A2	Deeply incised, high gradient, mountain slope channel
A4	Shallowly incised, very high gradient, mountain slope channel
A5	Deeply incised, high gradient, mountain slope channel
B4	Shallowly incised, moderate gradient, transitional footslope channel
B7	Deeply incised, moderate gradient, transitional channel
C5	Moderate to deeply incised, low gradient lowland channel
Uncontained Channel Types	
A3	Non-incised, high gradient, alluvial/colluvial fan channel
B2	Shallowly incised, moderate gradient, footslope channel
B3	Mixed control, moderate gradient channel
E2	Shallowly incised, moderate gradient, intertidal channel

Source: USDA Forest Service

infrequently. A barrier to anadromous fish migration is present about 1,100 feet upstream of the mouth.

The reaches between the anadromous barrier and the confluence of Ophir Creek, a distance of 4,500 feet, is steep (B7 Channel Type), containing a number of falls. The percentages of water surface area contained in pools, riffle, glide and falls in July 1991 were 20 percent, 31 percent, 1 percent, and 48 percent. The stream is deeply incised in bedrock and canyon throughout much of this distance.

The middle reaches of Sherman Creek upstream of Ophir Creek to the vicinity of the proposed flow diversion (A2 Channel Type) contains habitat more suitable for rearing fish than areas downstream. The stream is relatively steep, with the gradient varying between 2 to over 10 percent and averaging about 7.5 percent. The stream bed is composed of boulders, cobbles and substantial bedrock intrusions. Accumulations of large woody debris are relatively common, providing shelter for resident char. The percentages of pool, riffle, glide and falls in these reaches in July 1991 were 10 percent, 86 percent, 2 percent, and 2 percent.

Tributaries include Ophir Creek to the north and an unnamed stream originating to the south. These streams are quite steep, containing small proportions of pool habitat.

Sherman Creek is relatively dynamic, as evidenced by habitat changes resulting from the major storm event that occurred in September 1991. Embankment cutting, changes in channel configuration, and substantial bedload movement resulted from this event.

Continuous stream temperature monitoring in lower Sherman Creek was initiated in April 1991. Water temperatures recorded in summer 1991 ranged between approximately 2.5 to 10.0° C, with diurnal fluctuations of 1 to 2° C. Temperatures were similar in both the upper and lower reaches of the stream.

Sweeny Creek. Sweeny Creek drains a watershed of about 4.08 square miles, having a northwestern aspect. The watershed is moderately steep, rising to a maximum elevation of 2,700 feet. Sweeny Creek flows into Lynn Canal over a cobble beach about 0.25 mile northeast of Point Sherman.

The lower reach (B3 Channel Type) is accessible to anadromous fish for at least 2,600 feet upstream; stream length available to anadromous migration appears to fluctuate depending on conditions during a given year, i.e. flow and presence or absence of debris jams. The stream in this reach has a gradient of about 3 percent, with a substrate composed mainly of large cobbles and boulders. Spawning gravel occurs in small patches, which are widely separated. The percentages of pool, riffle and glide in this reach in July 1991 were 13 percent, 80 percent, and 7 percent.

The middle reaches of Sweeny Creek (B7 Channel Types), includes a tributary, referred to here as East Branch. East Branch is steep and cascading (primarily A2 and A5 Channel Types) with a bed composed mainly of bedrock with boulder accumulations along the stream margins. Little cover is present in East Branch.

The middle reaches downstream of East Branch are paved by bedrock, large boulders and cobbles. Bedrock slides are relatively common. Large scour elements have produced deep pools, providing areas of refuge for fish during high flow events. The percentages of pool, riffle and glide habitat in these reaches in July 1991 were 22 percent, 66 percent, and 12 percent.

The mainstem of Sweeny Creek has a 30-foot waterfall near the confluence of East Branch. Upstream from the falls, the stream has a lower gradient than East Branch, averaging about 2 percent. Some accumulations of woody debris are present along with depositional areas, scour pools and shelter habitat.

Sweeny Creek appears to be very dynamic, more so than Sherman Creek. The major storm event that occurred in September 1991 caused severe disruption to the channel and its configuration, particularly in the lower stream reaches. Several large slides occurred in the area and resulting in significant scour and bedload movement.

Continuous temperature monitoring in lower Sweeny Creek was initiated in April 1991. Water temperatures recorded in summer 1991 ranged

between approximately 3.0 to 13.5° C, with diurnal fluctuations of 1 to 2° C. Temperatures were significantly higher than those in Sherman Creek during July, likely due to the presence of substantial muskeg areas in upper Sweeny Creek (Konopacky, 1991).

Slate Lakes and Slate Creek. Two lakes lie east of Slate Creek in an unnamed tributary watershed about 1.5 square miles in area. The upper lake is over 1,150 feet long with an average width of about 430 feet; the surface area is approximately 12 acres. The lower lake is nearly 1,600 feet long with an average width over 600 feet; surface area is about 20 acres. Both lakes are moderately deep with maximum depths of between 40 to 50 feet. Dolly Varden are present in both lakes (Buell, 1989).

Anadromous fish access to Slate Creek is limited to the lower 2,600 feet of stream by a barrier waterfall. Pink salmon spawn downstream of the falls. In August 1990, an estimated 1,500 to 2,000 pink salmon spawners were observed by MJM Research personnel in the lower portions of the creek.

Habitat Capability Modeling

As part of the planning process for the Tongass National Forest, stream reaches within the Sherman and Sweeny creeks have been classified according to a forest-wide stream typing system developed jointly by the Forest Service, NMFS, and ADF&G. The classification is based on distinguishable channel segments that have relatively similar physical attributes (Paustian, 1990). Stream reaches within the forest have been typed using topographic base maps, with some reaches having extensive ground truthing for identifying key features.

One of the major purposes for the stream classification system is to estimate potential fish production, defined as the habitat capability for each stream (Paustian, 1990). Juvenile fish densities have been sampled in numerous stream reaches of varying stream types throughout Southeast Alaska. These data are being used to model habitat capabilities for coho salmon and Dolly Varden (Kessler, 1990; Paustian, 1990). Although the procedure is best applied to broad land use planning, it provides a relative measure of the general suitability of individual streams to produce fish. In addition, the model offers a means of evaluating mitigation strategies.

Figure 3-20, Channel Classification for Sherman and Sweeny Creeks, shows how the project area streams have been typed for the Tongass Forest Plan. Definitions of channel types are given in *Table 3-9, Channel Type and Geomorphic Characteristics*. Channel types are categorized as either being contained (i.e., contained by an incised channel with stable well defined banks as in a canyon) or uncontained (i.e., having a channel with a floodplain and subject to shifting).

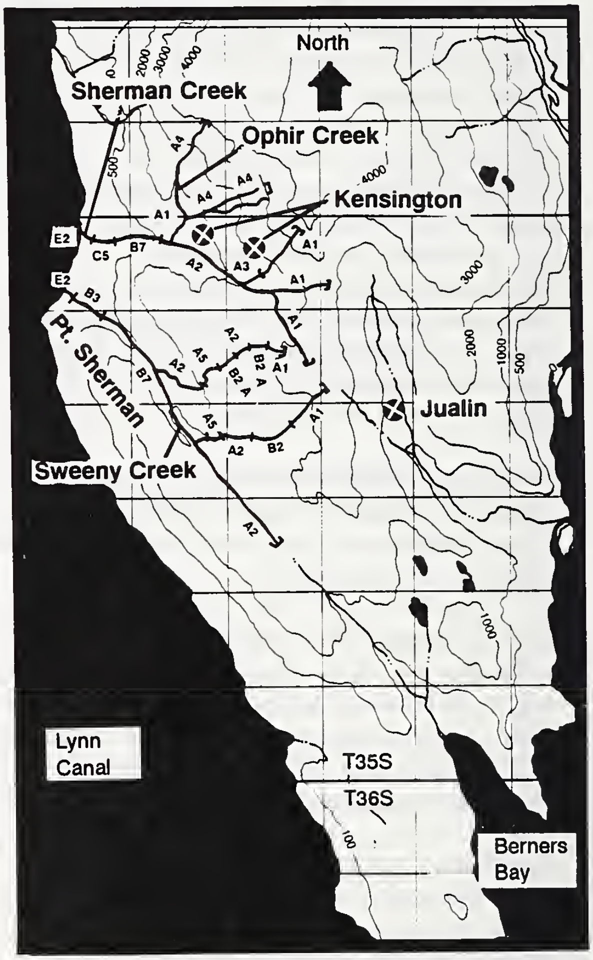


Figure 3-20, Channel Classification for Sherman and Sweeny Creeks

Table 3-10, Sherman and Sweeny Creeks Channel Types with Habitat Capability Estimates for Coho Salmon and Dolly Varden Char, provides a breakdown of the output of modeling potential fish production for reaches of project area streams. These data show that over 95

Table 3-10, Sherman and Sweeny Creeks Channel Types with Habitat Capability Estimates for Coho Salmon and Dolly Varden Char

Stream Channel Type	Category	Channel Length (ft)	Percent of Total	Coho Winter Capability (fish/100 sq. ft.)	Dolly Varden Winter Capability (fish/100 sq. ft.)
Sherman Creek					
A1	contained	13,300	36.4	0.00	0.00
A2	contained	6,704	18.3	0.09	2.69
A3	uncontained	1,018	2.8	0.00	1.30
A4	contained	9,971	27.3	0.00	0.00
B7	contained	3,870	10.6	0.00	1.67
C5	contained	1,019	2.8	0.37	0.84
E2	uncontained	667	1.8	0.00	0.00
Total		36,549			
Sweeny Creek					
A1	contained	4,006	11.7	0.00	0.00
A2	contained	12,253	35.8	0.09	2.69
A5	contained	3,699	10.8	0.09	2.97
B2	uncontained	1,764	5.2	0.46	1.11
B2/4	transitional	2,308	6.7	0.46	1.11
B3	uncontained	1,277	3.7	0.46	3.53
B7	contained	8,483	24.8	0.00	1.67
E2	uncontained	438	1.3	0.00	0.00
Total		34,228			

percent of Sherman Creek consists of contained channel and that more than 60 percent of the stream reaches are too steep to support fish production. Habitat capability estimates are given for winter juvenile densities, since this season is likely limiting to fish production in these streams.

Habitat capability estimates are expressed as the fish density for 100 square feet of stream surface area. These estimates provide a relative measure of the productive potential of each stream type.

Results of habitat modeling for Sherman Creek predict that the lowest fish production potential in the drainage per unit surface area occurs downstream of the anadromous barrier. The anadromous reaches (Channel Types E2 and C5) have relatively low potential for overwintering juvenile fish production, both for coho and Dolly Varden. For Dolly Varden, the only channel types with lower potential production are those types having no potential.

The model predicts much higher Dolly Varden potential for Sherman Creek above the anadromous barrier, although model input does not consider whether stream reaches support resident or anadromous forms of the species. Much of the input data was collected in reaches accessible to anadromous fish and therefore contains a significant contribution from the sea-run form. Because of this, the model over predicts the productive potential in numbers of fish for resident populations in stream reaches above anadromous barriers. These stream reaches support both juvenile and adult fish, while reaches below anadromous barriers are principally rearing areas for juvenile Dolly Varden.

Approximately 90 percent of the channels within the Sweeny Creek drainage are categorized as

being contained within well defined, incised channels. In contrast to Sherman Creek, the model predicts that only 13 percent of the stream channels are too steep to support fish production. The Sweeny Creek drainage appears to be capable of supporting fish production far into the headwaters, and as such, may offer good potential for habitat enhancement as a means of project mitigation, if deemed necessary.

The model also predicts that more of Sweeny Creek is suited to produce coho than is Sherman Creek, although most of these reaches are upstream of areas predicted to be void of coho. Considering only the lower stream reach, known to be inhabited by anadromous fish, the model predicts that the stream is only slightly more productive for coho than Sherman Creek.

Assessment of Rearing Populations

Fish populations in Sherman and Sweeny creeks were inventoried in July 1991 (Konopacky Environmental, in press). Results of this work provide a means of validating model predictions previously described and for bench marking existing levels of production.

In Sherman Creek, the entire reach downstream of the anadromous barrier was inventoried. Upstream of the barrier, the mainstem of the creek was assessed up to an elevation of 650 feet, or the level of the top of the proposed tailings impoundment. Tributaries were also inventoried to the same elevation. Konopacky (1991) stated that the density of fish in the mainstem above this elevation up to the proposed diversion structure (elevation 800 feet) was approximately the same as that in the reach between Ophir Creek and the 650 feet elevation.

Sweeny Creek was inventoried from the stream mouth upstream a distance of 4,800 feet. Comparable densities of Dolly Varden were judged to exist for a substantial distance upstream of that point.

Over a distance of 13,800 feet of channel in Sherman Creek, a total of 420 Dolly Varden were estimated to be present (*See Table 3-11, Numbers and Densities of Trout and Dolly Varden in Sherman and Sweeny Creeks, July, 1991*). Overall the density of this species was estimated to be 0.19 fish/100 ft^2, though the density above the anadromous barrier was estimated to be twice that below the barrier. These values are significantly less than winter densities predicted from the habitat capability model (*See Table 3-12, Dolly Varden Densities in Sherman Creek (fish/100ft)* The greatest discrepancy between predicted and observed values occurred upstream of the anadromous barrier, likely for reasons described earlier. The model correctly predicted that habitat upstream of the barrier is more productive for Dolly Varden than areas downstream.

Only a relatively few trout were found in Sherman Creek, and those all occurred below the anadromous barrier.

Table 3-11, Numbers and Densities of Trout and Dolly Varden in Sherman and Sweeny Creeks, July, 1991

Stream/Section	Length (ft)	Surface Area (ft^2)	Rainbow/Cutthroat		Dolly Varden	
			No.	Fish per 100 ft^2	No.	Fish per 100 ft^2
Sherman/below[1]	1,200	27,500	28	0.10	28	0.10
Sherman/above[2]	13,800	194,400	0	0.00	392	0.20
Sherman Total	15,000	221,900	28	0.01	420	0.19
Sweeny	4,800	82,200	1,226	1.49	115	0.14

[1]Sherman Creek downstream of the anadromous barrier.
[2]Sherman Creek upstream of the anadromous barrier.

Table 3-12, Dolly Varden Densities in Sherman Creek (fish/100 sq. ft.)

Migration Barrier	Predicted (O)	Observed (P)	O/P
Below	0.50	0.10	0.20
Above	1.60	0.20	0.12

Over a distance of 4,800 feet of channel in Sweeny Creek, a total of 115 Dolly Varden were estimated to be present (*See Table 3-11, Numbers and Densities of Trout and Dolly Varden in Sherman and Sweeny Creeks, July, 1991*). This resulted in a density of 0.14 fish/100 ft^2, less than in Sherman Creek as a whole. However, a substantial number of trout were found in Sweeny Creek, which resulted in an overall density for trout and char combined substantially higher than in Sherman Creek. Many of these fish in Sweeny Creek were likely anadromous forms of the species.

Dolly Varden found in Sherman Creek, particularly those sampled above the anadromous barrier, were relatively small. In those upper reaches, for example, all were less than 8 inches in length; 97 percent were less than 6 inches in length, and about 65 percent were less than 4 inches in length.

These findings of low densities and small fish in Sherman Creek above the anadromous barrier are consistent with observations made elsewhere on resident salmonid populations in steep headwater streams. Populations of resident Dolly Varden in small streams of southeast Alaska are characterized by individuals exhibiting small size, early maturity, reduced fecundity, and shortened life span (Blackett, 1973). Resident stream populations with these characteristics are normally low in abundance, typifying comparatively unproductive coastal headwater streams (Lestelle, 1978).

Most fish in Sweeny Creek were also small, with over 86 percent smaller than 4 inches. The majority of these fish were likely juveniles of anadromous forms.

Spawner Abundance

The abundances of salmon spawners were assessed in Sherman and Sweeny creeks in 1990 and 1991 (Pentec, 1990; Konopacky, in press). Weekly counts were made during August and September to estimate the number of pink salmon spawners. The surveys were conducted in the lower 1,100 feet of each stream.

In 1990, the numbers of spawners peaked on August 24, when approximately 2,200 and 1,700 fish were counted in each stream (*See Figure 3-21, Numbers of Spawning Pink Salmon Adults in Project Area Streams, 1990 - 1991*). No surveys could be made on this date in 1991 due to a storm event; data for other dates during 1991 suggest that spawning peaked on about the same date as in 1990. However, the abundances of fish in 1991 were only a small fraction of those seen in 1990.

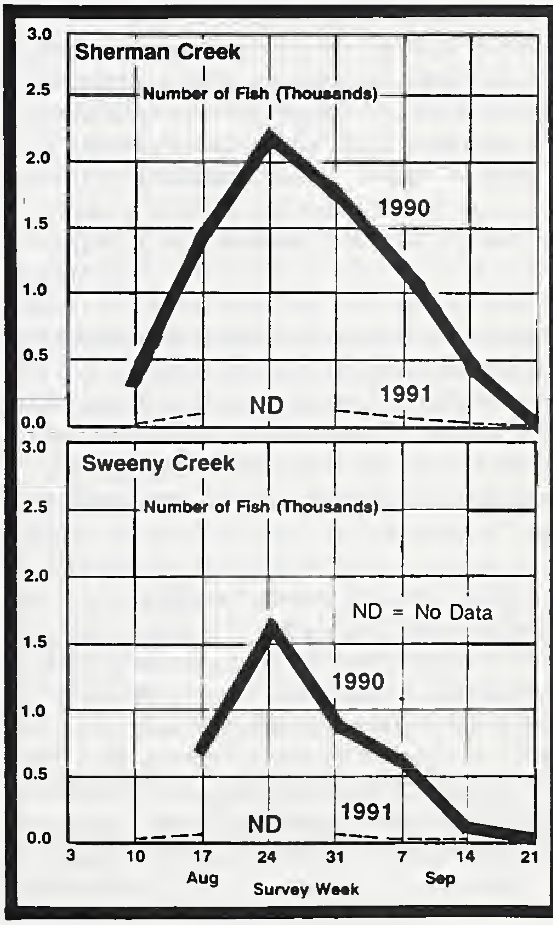


Figure 3-21, Numbers of Spawning Pink Salmon Adults in Project Area Streams, 1990 - 1991

By applying an assumed stream residence time of 2 weeks, a value typically encountered in Southeast Alaska streams (Perrin and Irvine, 1990), estimates were derived of the total number of spawners escaping into each stream. The estimated numbers of fish in 1990 were 3,600 and 2,000 pink salmon in Sherman and Sweeny creeks, respectively. Estimated totals for 1991 were approximately 300 for Sherman Creek and less than 100 in Sweeny Creek.

SOILS/VEGETATION/WETLANDS

SOILS

The soils of the study area have been strongly influenced by an extensive history of glaciation that has occurred throughout Southeast Alaska. As a result, all of the soils are very young with respect to the normal processes of soils development. High levels of rainfall in this region promotes extensive plant growth and considerable amounts of organic matter have been produced. However, cool temperatures and very moist conditions during a relatively short growing season inhibit decomposition of this organic matter. These conditions discourage the development of mineral soils and, instead, favor the development of organic soils.

Due to the processes associated with glaciation, numerous depressions and extensive impermeable soil layers are present throughout the landscape. These areas often contain peat deposits (Harris and Farr, 1974) ranging from 2 to 40 feet in thickness and are commonly called "muskegs."

The soils of the project area have been characterized and mapped by previous studies and mapping efforts. Existing soils data were supplemented by extensive onsite testing performed in connection with geological exploration, geotechnical engineering, and soils and wetland delineation efforts. A complete description of existing information and onsite soils field studies is provided in IME (1991a).

General Soil Properties

On a national scale, the unique feature of the soils in Southeast Alaska is the predominance of organic soils. These soils have developed on moderate and steep slopes in till or colluvium. They typically have a dense forest cover composed mainly of spruce and hemlock and a moderately thick understory of shrubs. These soils support timber production, watershed protection, and wildlife habitat. Precipitation is high and temperatures are cool in summer and winter, but the soils are seldom frozen. The principal associated soils are typically found on gently sloping beaches adjacent to tidal water or on foot slopes and benches (USDA, SCS, 1975).

On a regional scale, the soils of the study area are characterized as very porous and friable, and extremely acidic, except in the lowest horizons that overlie calcareous bedrock. Water holding capacity of these soils is very high, and soil moisture is ample for tree growth in all but extreme instances. Soil moisture tensions are rarely high enough to significantly reduce tree growth. The soil materials are water erosion resistent (except in a few gravelly soils) and are readily disturbed by compactive forces (Stephens et al., 1969).

The typical chemical and physical properties of the soils on the Tongass National Forest have been summarized by Stephens et al. (1969). Representative data for the major soil types are presented in *DEIS Appendix Table D4-1, Chemical and Physical Properties of Tongass Area Soils*. Examination of these data reveal that soils are typically acidic, especially in the surface horizons. Plant nutrients are largely confined to the surface organic layer and probable deficiencies occur in nearly all subsurface horizons. Phosphorous appears to be especially limiting with respect to plant growth.

Management implications for these soils are summarized in *DEIS Appendix Table D4-2, Management Interpretations of Tongass Area Soils*. This comparison suggests that most soils have a low susceptibility to induced sediment production. Landslides are a common problem with Alaska soils and this comparison suggests that certain soils have a high potential of being

prone to landslides. The depth to the seasonal ground water table is usually quite shallow. Compactibility is often a problem in organic soils. Soil depths are typically quite shallow as a result of an extensive history of glaciation in the area (the most recent only 200 years ago). The wetness of soils can cause problems with cut slope bank failure.

Soil Mapping and Soil Types

The Kensington soils study area is defined as the area between Lynn Canal and Berners Bay and Berners River north to an east-west cutoff approximately 2 miles north of Lions Head mountain. An Order 4 level of soils survey was completed for this area by the USDA Forest Service (1990a). This survey is of sufficient detail to facilitate broad planning decisions. A total of 47 soil map units have been delineated within the soils study area. These soil map units contain a total of 30 soil types. Excluding miscellaneous land types such as rock outcrop, glaciers and water, the study area contains a total of 29,131 acres of taxonomically identifiable soils. Mineral soils account for 68.9 percent of the study area, and organic soils account for 31.8 percent of the area. Additional information on the distribution, extent, types and characteristics of soils within the study area is contained in *DEIS Appendix D4, Soils Information.*

Soil Sampling

Representative samples of several soil and mine soil materials were collected and analyzed within the Kensington Project area in order to characterize the properties of these soils materials. Site specific sampling and measurements of the soils within the Kensington Project area was conducted on numerous sites within potential development areas including Sherman Creek basin, Sweeny Creek basin, and along the proposed Berners Bay assess road. Results of these evaluations are presented in *DEIS Appendix Table D4-5, Kensington Soil Materials Chemical and Physical Properties.* An analysis of potentially toxic elements contained within these same samples is summarized in *DEIS Appendix Table D4-6, Kensington Soil Materials EP Toxicity Analyses.*

VEGETATION

The dominant vegetation of southeastern Alaska has been described as a coastal rain forest due to the proliferation of plant growth that occurs in this area. This type is comprised of several tree species. The most common forest type found in the region Is the Coastal Spruce - Hemlock Forest (Viereck and Little, 1972). The Forest Service has prepared a Forest Type Map which was used as the basis for the vegetation map of the study area. A mapping of plant communities and associated acreages are presented in *DEIS Appendix D4.* The following sections present a brief characterization of the major vegetation communities. A more detailed discussion of specific plant associations is provided in *DEIS Appendix D4.*

Coniferous forest is the most extensive vegetation type within the study area. It occurs over a broad range of upland slopes and aspects. This forest type is characterized by an overstory dominated primarily by western hemlock (*Tsuga heterophylla*) at the lower elevations and mountain hemlock (*Tsuga mertensiana*) at the higher elevations with minor amounts of Sitka spruce (*Picea sitchensis*) occurring throughout.

Sitka spruce is more dominant along the edges of drainages, avalanche chutes, and the beach fringe. Understory density and species within this habitat varies depending on slope, aspect, and the degree of canopy closure, but Alaska blueberry (*Vaccinium alaskaense*) and, to a lesser extent, rusty menziesia (*Menziesia ferruginea*) are the principal shrubs. Devil's club (*Opopanax horridum*) and salmonberry (*Rubus spectabilis*) also are present. Representative herbaceous plants include five-leaf bramble (*Rubus pedatus*), bunchberry (*Cornus canadensis*), deerberry (*Maianthemum dilatatum*), fern-leaf goldthread (*Coptis asplenifolia*), deer fern (*Blechnum spicant*), and spinulose shield fern (*Dryopteris austriaca*).

Alder shrubland occurs primarily in avalanche chutes and as small pockets of habitat along drainages. This vegetation is dominated by dense stands of Sitka alder (*Alnus sinuata*) 5 to 15 feet in height. Willow (*Salix* spp.), salmonberry, and devil's club are also occasionally present, especially near the edges

of this habitat and coniferous forest. Throughout much of this habitat, canopy cover by Sitka alder exceeds 70 percent, and therefore, understory is limited to scattered small grasses and forbs.

Deciduous forest is the least extensive upland habitat within the study area. It occurs only as small pockets of habitat near the beach fringe and moist areas. These pockets of habitat are dominated by red alder (*Alnus rubra*) and black cottonwood (*Populus trichocarpa*). Willow and Sitka alder represent the shrub component, while the herbaceous understory is comprised of various forbs and grasses.

Wetland plant communities represented are muskeg/open shore pine forest, wet coniferous forest, and sedge/grass/forb meadows.

Wet coniferous forest is the most extensive general wetland type in the study area. It is similar to hemlock/ spruce forest except that this habitat occurs on poorly drained sites where surface or subsurface moisture has saturated soils. This habitat is well represented within the study area and often forms a mosaic of forested habitats with coniferous forest. Standing or flowing water is frequently present in low areas throughout the understory of wet coniferous types. The understory is dominated by skunk cabbage (*Lysichitum americanum*) and devil's club. Alaska blueberry and rusty menziesia also are present but are less prevalent than in conifer forest. Other common understory species include False hellebore (*Veratrum viride*) and deer cabbage (*Fauria crista-galli*).

Muskeg is the second most extensive wetland habitat within the study area. This habitat varies from open with virtually no trees to open forested areas. Open forested portions support small stands of stunted lodgepole or shore pine (*Pinus contorta*), western hemlock, and Sitka spruce. The forested portions of muskeg support a relatively diverse shrub understory represented by Sitka alder, bog kalmia (*Kalmia polifolia*), crowberry (*Empetrum nigrum*), highbush cranberry (*Viburnum edule*), bog cranberry (*Vaccinium oxycoccos*), Labrador tea (*Ledum groenlandicum*), huckleberry (*Vaccinium parvifolium*), blueberry, and rusty menziesia.

In the open, treeless muskeg, herbaceous species, mosses, and lichens are most common. Representative herbaceous species in both forested muskeg and open muskeg areas include sedges (*Carex* spp.), bluejoint reedgrass (*Calamagrostis canadensis*), skunk cabbage, marsh marigold (*Caltha biflora*) and mosses, including sphagnum. In many portions of the more open areas of muskeg, small pools of water, ranging from a few inches to several feet deep, are relatively common. In the wetter areas around the edges of these pools, short sedges, cotton grass (*Eriophorum* spp.), marsh marigolds, and spike rushes (*Juncus* spp.) are the primary species.

Sedge/grass/forbs meadows occur in small pockets adjacent to open water at Independence Lake, Slate Creek Lakes area, and in narrow strips along portions of the beach fringe. Where this habitat is adjacent to freshwater, tall sedges, horsetail (*Equisetum equisetaceae*), and bluejoint reedgrass are the dominant species. Sphagnum moss is often present in the understory. Along the beach fringe, common species include seaside plantain (*Plantago macrocarpa*), silverweed (*Potentilla anserina*), dune wildrye (*Elymus* sp.), beach pea (*Lathyrus japonicus*), cow parsnip (*Heracleum lanatum*), sedges, and seaside arrowgrass (*Triglochin maritima*).

Disturbed areas such as historic mining sites, current exploration development sites, and mine tailings also occur within the study area. Logging and past mining operations have resulted in minor (in terms of relative acreage) alterations of existing vegetation. Existing development areas that have been cleared of trees occupy approximately 15 acres within the study area. Areas that were logged in the past and that currently support stands of second growth timber comprise about 938 acres of the study area.

Talus slopes and areas of rock outcrops occur as special habitats within the study area. They are located primarily on steep slopes above timberline and in avalanche chutes where vegetation and soil have been removed by snow slides. Vegetation in these areas is typically sparse, and where present, is usually stunted by harsh environmental conditions.

Aquatic habitat in the study area is represented by streams, small freshwater lakes and ponds, and offshore marine habitats. Permanent sources of flowing freshwater occur in Ophir Creek, Sherman Creek, Sweeny Creek, Slate Creek, and numerous other small unnamed drainages. In general, these streams are narrow, have relatively steep gradients, and occur in deeply incised channels. As a result there is little pool formation within the stream channels or establishment of riparian vegetation along the streambanks. In most areas, hemlock/spruce forest or wet coniferous forest occurs up to the upper edge of the streambank. Sitka alder and willow occur in isolated pockets at scattered locations along some of the streambanks.

Wetlands Mapping

The Federal government, through Executive Orders 11988 and 11990, has mandated that Federal agencies provide leadership for preserving floodplains and minimizing losses of wetlands. Wetlands mapping, as delineated by the Tongass National Forest and the U.S. Fish and Wildlife Service's National Wetland Inventory, was reviewed for a preliminary evaluation of the extent of potential jurisdictional wetlands within the study area. Due to the very large scale base maps utilized in the Tongass and USFWS efforts (1:63,360), it is impossible to obtain the detail from these map scales required by the 404 permitting requirements. As a result, site specific wetland delineation efforts for areas proposed for disturbance were completed during August, 1990 (IME, 1991b). This survey was conducted using the procedures outlined in the *Federal Manual for Delineating Jurisdictional Wetlands* (Federal Interagency Committee for Wetland Delineation, 1989).

Because of the size of the study area, detailed jurisdictional wetland delineation was only conducted over potential disturbance areas. The Tongass wetland mapping is provided to give an overview of wetlands within the entire study area (*See Figure 3-22, Wetlands Map*). It was decided to utilize the Tongass wetland mapping since it tended to show a larger extent of wetland acreage than did the USFWS National Wetland Inventory Mapping.

Ninety-two wetland plots in the Kensington Project area were sampled and evaluated using the criteria detailed in the Federal Interagency Committee for Wetland Delineation (1989). Jurisdictional wetlands were delineated by the

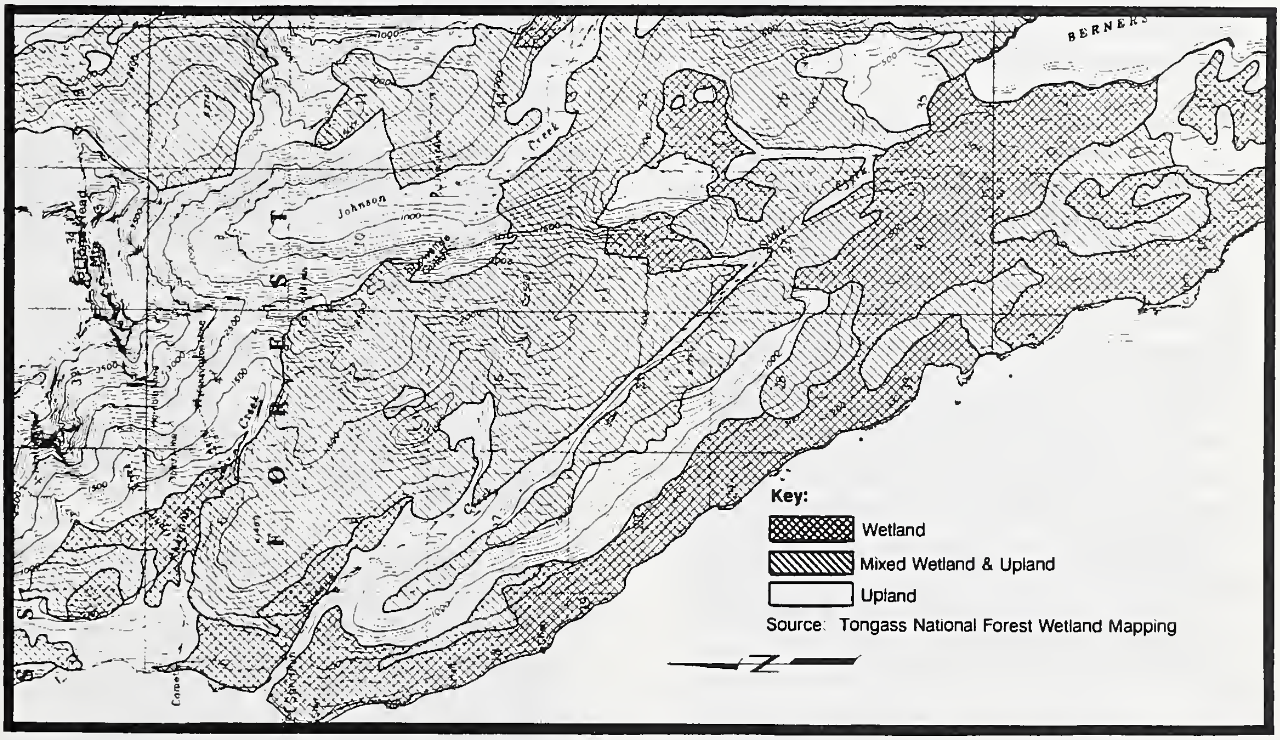


Figure 3-22, Wetlands Map

Sherman Creek Basin, the proposed Sweeny Creek tailings impoundment site, and along the entire length of the proposed Berners Bay access road.

The onsite wetland surveys documented that, except for minor areas, nearly all of the Sherman Creek basin, all of the Sweeny Creek tailings impoundment area, and the entire length of the proposed Berners Bay access road met the criteria for jurisdictional wetlands. The survey found that wetlands existed on all but the steepest mountain slopes in the study area (IME, 1991b).

The results from this survey (IME, 1991b) were presented to the Corps of Engineers in September 1989 and subsequently approved. Since that time, the 1992 Energy and Water Development Appropriations Act mandated the use of the 1987 Corps of Engineers Wetlands Delineation Manual (Environmental Laboratory, 1987) for wetland delineations instead of the Federal Manual for Delineating Jurisdictional Wetlands (Federal Interagency Committee for Wetland Delineation, 1989). The Corps of Engineers has reevaluated the August 1990 wetland delineation performed for the Kensington Project, and as a result has determined that the wetland determinations would remain essentially the same based on the 1987 manual (Justis, 1991).

Wetland Functions and Values

Extensive literature review and field studies have been conducted for the wetlands in the Juneau area (Adamus Resource Assessment, Inc. 1987a). As a result of these studies, modifications to the original Wetland Evaluation Technique (WET), recommended for the conterminous United States (Adamus et al., 1987), were proposed for Southeast Alaska (Adamus Resource Assessment, Inc., 1987b). The WET recommended for Southeast Alaska was used to evaluate plant associations and aquatic sites in the portions of the project area potentially disturbed by the action alternatives. The results of this evaluation are presented in *DEIS Appendix Table D4-11, Kensington Wetlands Functions and Values*.

Threatened and Endangered Plant Species

The potential presence of threatened and endangered plant species on the study area was determined through consultations with the Tongass National Forest, the USFWS, and the Alaska Natural Heritage Program. Four federally listed plant species (*Carex lenticularis* var. *dolia, Poa merrilliana, Rhinanthus arcticus*, and *Thlaspi arcticum*) are known to occur on the Tongass. Four additional species (*Aster yukonessis, Calamagrostis crassiglumis, Montia bostockii, Poa norbergii*) potentially are present. It has been determined through consultation between the Forest Service and the USFWS on the proposed revisions to the Tongass Land Management Plan that "no adverse effects are anticipated on these species with any of the alternatives," (USDA Forest Service, 1990a).

Consultation with the Alaska Natural Heritage Program determined that 37 plant species proposed for listing as "state sensitive" could potentially occur in the project area. The species are: *Cryptogramma stelleri, Cirsium foliosum, Lactuca biennis, Saussurea americana, Betula papyrifera* var. *commutata, Cardamine pratensis* spp. *anguitifolium, Symphoricarpos albus* ssp. *laevigatus, Stellatia crassifolia, Atriplex drymarioides, Carex atratiformis* ssp. *raymondii, Carex bebbii, Carex interior, Eleocharis kamtschatica, Eriophorum viridicarinatum, Chimphila umbellata* var. *occidentalis, Vicia americana, Satureja douglasii, Smilacina stellata, Botrychium virginianum* ssp. *europaeum, Calypso bulbosa, Cypripedium calceolus* ssp. *parviflorum, Cypripedium montanum, Malaxis monophyllos, Malaxis paludosa, Platanthera chorisiana, Platanthera unalaschecensis, Pinus contorta* ssp. *latifolia, Armeria maritima, Puccinellia hultenii, Puccinellia kamtschatica, Dodecatheon pulchellum* ssp. *alaskanum, Galium kamtschaticum, Mitella nuda, Mitella trifida, Castilleja chrymactis, Euphrasia mollis*, and *Viola selkirkii*.

Field investigations were conducted from August 13 through September 17, 1990 to determine the possible presence of these plant species within potential disturbance areas. This survey was conducted in connection with intensive wetland surveys performed in all of the areas proposed for disturbance. Two additional

days were devoted specifically to collecting plant specimens. In these surveys all of the plant species found in the vicinity of 92 wetland plots were identified. Taxonomic sources used to identify plants were Welch (1974) and Hulten (1968). While this survey was conducted somewhat late in the growing season, little difficulty was encountered in proper identification of plants and nearly all possessed sufficient floral parts to confirm species identity.

The potential occurrence of many of these species was ruled out due to the lack of suitable habitat. Others were deemed not to occur in the area due to the failure to encounter the plant group in question. The presence of only one species proposed for listing as state sensitive was verified in the project area. This species was western paper birch (*Betula papyrifera* var. *commutata*). This finding is not surprising since the site is within the known range of this species as outlined by Viereck and Little (1972). Observations regarding this species suggest that it is somewhat common in the project area and discussions with various mine project employees who were familiar with this tree species revealed that they had seen this species over a very widespread area. Given the rather widespread distribution of western paper birch, it is the opinion of several botanists familiar with this area that this species will not make the state sensitive species list once it is finalized (IME 1991b).

WILDLIFE

Site-specific field studies, regional published information, and agency file data were reviewed to obtain information on the wildlife resources within the project area. In addition, persons having knowledge of the project area were interviewed. Baseline studies were conducted in the study area from the fall of 1988 until early summer 1990. Wildlife monitoring continues in conjunction with the Alaska Department of Fish and Game (ADF&G). Methods employed for the baseline studies and the results of these studies are described in Cedar Creek Associates, Inc. (1991). For clarification purposes, throughout this section the term "project area" refers to all specific sites potentially disturbed by project development alternatives, while "study area" refers to a somewhat larger area that encompasses all project development sites and field survey areas.

Consultations with State and Federal wildlife agencies have been conducted throughout the scoping process. As a result of these interagency coordination meetings, several key species of special concern were identified: black bear (*Ursus americanus*), brown bear (*Ursus arctos*), gray wolf (*Canis lupus*), mountain goat (*Oreamnos americanus*), mink (*Mustela vison*), bald eagle (*Haliaeetus leucocephalus*), and Vancouver Canada goose (*Branta canadensis fulva*). These species are also Management Indicator Species for the Tongass National Forest. Because of their potential sensitivity to project development, these species have received greater emphasis in the baseline description sections and some have been targeted for future monitoring efforts within the Kensington Project study area.

Resident and migratory wildlife populations occurring within the study area are discussed under the following categories.

- Marine Mammals
- Big Game
- Furbearers
- Other Mammals
- Waterfowl and Other Waterbirds
- Raptors
- Upland Game Birds
- Other Avifauna
- Amphibian
- Threatened and Endangered Species

MARINE MAMMALS

Marine mammals known to occur in the marine waters of Lynn Canal include Steller sea lion (*Eumetopias jubatus*), harbor seal (*Phoca vitulina*), humpback whale (*Megaptera novaeangliae*), killer whale (*Orcinus orca*), minke whale (*Balaenoptera acutorostrata*), Dall's porpoise (*Phocoenoides dall*), and harbor porpoise (*Phocoena phocoena*), (NMFS, 1974). Although the presence of these species has been documented within Lynn Canal, no population estimates are available for the canal area. The Steller sea lion is listed as threatened, while the humpback whale is listed as endangered. The Steller sea lion and

humpback whale were the only species recorded by incidental observation near the project area during field survey periods. These two species are discussed in a subsequent section, *Threatened and Endangered Wildlife Species*.

The killer whale and minke whale are the only other whales expected to occur in Lynn Canal offshore of the project area (Pitcher, 1990). The killer whale has a worldwide distribution especially in cooler more productive coastal waters. Killer whale movement and migration appears to be dependent on changes in food supply (NMFS, 1974). This animal travels in pods of five to 40 animals, but pods of about 10 animals are more typical. They feed on seals, sea lions, porpoise, whales, birds, fish, and squid. The minke whale is fairly common in coastal waters of North America. It occurs off the Alaskan coast only during the summer months. They do not appear to be abundant within Lynn Canal (NMFS, 1974). Minke whales feed mainly on small shoal fishes and krill.

Dall's porpoise may be the most abundant small cetacean (dolphins, porpoises, or whales) in the inside marine waters of Alaska (NMFS, 1974). They move in the spring from the Gulf of Alaska to the Bering Sea and return to the Gulf in the fall. They feed on squid and fish such as saury, hake, herring, and jack mackerel. Harbor porpoises are found along the Pacific Coast from the Arctic Ocean to Southern California. The harbor porpoise frequents cool coastal bays and the mouths of large rivers and feeds on a wide variety of small fishes and squids. On occasion, it can be found ascending fresh water streams. Its migrations are more inshore to offshore rather than north to south. Porpoises are commonly noted in the Point Sherman area by gillnetters during the summer months (Bruce, 1990).

The harbor seal is the only seal species known to occur in Lynn Canal. It is found in the waters of Lynn Canal year-round. They occur in nearly all marine habitats but tend to concentrate in estuaries and protected waters. Although population estimates of this species in Lynn Canal are not available, several hundred have been observed in the intertidal zone near the mouths of anadromous fish streams (NMFS, 1974). Harbor seals appear to use the delta area between the Lace and Antler Rivers within Berners Bay for pupping or pup rearing. Concentrations of seals and seal pups are observed in this area in the spring (Shaul, 1990b). Stowell (1972, as cited in NMFS, 1974) noted that harbor seals first appear in Berners Bay in conjunction with eulachon runs, and approximately 50 seals used Berners Bay throughout the summer. Harbor seals are known to swim up rivers emptying into Berners Bay to feed on salmon and cutthroat trout (Shaul, 1990b). Harbor seals feed singly or in small groups. Prey consumed is diverse and varies regionally and seasonally. Typical prey items include shrimps, octopus, and a variety of fish such as salmon, capelin, pollock, flatfishes, and sculpins.

Haulout sites are used by harbor seals for resting and pupping. They usually have direct access to deep water and protection from strong winds and high surf. Known harbor seal haulout sites in the region include Little Island, Kataguni Island, and the north end of Sullivan Island (Rusanowski, 1991).

BIG GAME

The project area occurs within Subunit 1C of the ADF&G's Game Management Unit 1. Sitka black-tailed deer (*Odocoileus hemionus sitkensis*), mountain goat, moose (*Alces alces*), brown bear, black bear, gray wolf, and wolverine (*Gulo gulo*) are the principal big game species occurring on or near the project area. Gray wolf and wolverine are also classified as furbearers and are discussed in a subsequent section, *Furbearers*.

Sitka Black-tailed Deer

Distribution mapping for the Sitka black-tailed deer (ADF&G 1973) indicates that the northern limit of this species is Berners Bay. However, observations of deer by mine personnel and deer sign (pellets and tracks) by an ADF&G biologist in 1991 indicate that a small population of Sitka black-tailed deer does exist near the project area (LeMond, 1991). Populations of Sitak black-tailed deer in the vicinity of the project area would be expected to remain small and vary from year to year because of heavy winter snow cover and predation by gray wolf.

Mountain Goat

Mountain goats occur throughout the mainland portions of Southeast Alaska where suitable habitat is present. A relatively isolated population of mountain goats referred to as the Lions Heads Mountain population resides near the project area. Mountain goat range in the vicinity of the project area has been mapped by the ADF&G (1973). (*See Figure 3-23, Mountain Goat Range*).

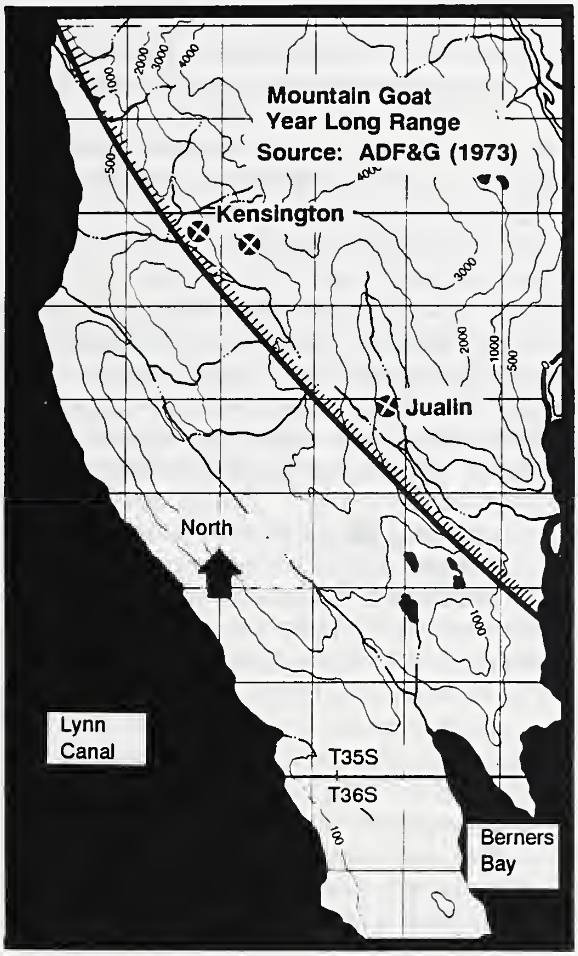


Figure 3-23, Mountain Goat Range

Long-term monitoring of the Lions Head mountain goat population was only initiated in 1990, but relatively intensive investigations have evaluated goat populations north of Juneau in the vicinity of Stroller White Mountain and the east side of Berners Bay near Echo Cove. Due to the proximity of these study areas to the Lions Head Mountain population and a similarity in habitats between the areas, it is assumed that habitat preferences of the Lions Head goat population are similar to those studied between Juneau and the project area.

Key factors related to mountain goat distribution in Southeast Alaska have been linked primarily to the presence of steep, rugged terrain and the availability of forage on a seasonal basis. The preference of mountain goats for steep, rugged terrain is well documented, and these areas are generally thought to be used as "escape terrain" to avoid predators. Escape terrain has been defined by Fox et al. (1989) as "slopes of 50 degrees or greater with the terrain surface being broken up, usually by rock outcroppings." In studies in Southeast Alaska, goat distribution (as determined by the presence of goat droppings and relocation of radio-collared goats) was restricted to primarily within 400 meters (1,300 ft) of steep and rugged terrain (Schoen and Kirchhoff, 1982; Smith, 1986; Fox, 1983).

Mountain goats feed on a variety of trees, shrubs, and herbaceous plants depending on availability and season. Elevational shifts in distribution and changes in foraging sites occur on a seasonal basis. In early spring, mountain goats utilize shrub communities on south-facing avalanche slopes (Schoen and Kirchhoff, 1982) as herbaceous vegetation initiates growth. As snow melt progresses during the summer, goats move to higher elevation subalpine and alpine habitats to feed on newly emerging plants.

Rock outcrops, alpine tundra, subalpine forest, and shrubland were the predominant habitat types used during the summer, while areas of rock outcrop, alpine tundra, and old-growth forest habitats were preferred in the winter (Schoen and Kirchhoff, 1982). In the warmer coastal areas, such as the project area where alpine habitats typically exhibit deep, dense snow cover, forested areas receive higher levels of winter mountain goat use (Fox et al., 1989). In these situations, the most forage is available in areas of old-growth forest where dense canopy cover limits snowfall accumulation. Open conifer forests and tall shrub stands on very steep slopes also can provide significant amounts of forage for goats. As winter progresses and snow accumulates, mountain goats tend to concentrate on patches of higher quality winter range.

Based on known mountain goat habitat requirements, the U.S. Forest Service and ADF&G have developed a preliminary Winter Habitat Capability Model for Mountain Goats in Southeast Alaska (Suring et al., 1988a). Habitat Information contained within the Forest Service Geographic Information System (GIS) database was incorporated into the model to produce mapping of potential winter habitat within the region of the project area. (*See Figure 3-24, Mountain Goat Winter Habitat Capability*). This mapping ranks potential winter habitat by Habitat Suitability Indexes (HSI).

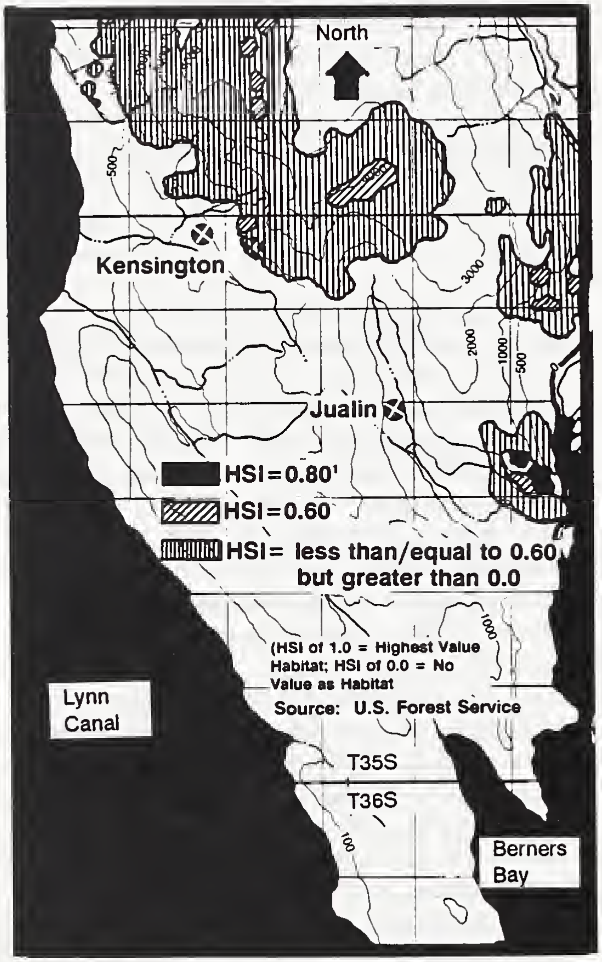


Figure 3-24, Mountain Goat Winter Habitat Capability

Locations within the study area where incidental, aerial survey, and ground survey observations of mountain goat or their sign have been recorded generally coincide with known habitat parameters, ADF&G (1973) mapping of mountain goat range, and potential winter range mapping developed from the habitat capability model. February, 1989 aerial survey observations of mountain goat tracks and winter incidental observations by contract pilots also indicate that a few mountain goats use areas of less steep slopes along the beach areas south of Point Sherman and the ridge west of Sweeny Creek and Slate Creek. However, ADF&G 1990 and 1991 radio-collar monitoring and on-ground surveys have not documented any mountain goat use of slopes south and west of Sweeny Creek (LeMond, 1991). Exploration personnel and contract pilots familiar with the area indicated that the majority of mountain goat observations made incidentally during the winter months were on slopes due east and above Independence Lake.

Walking transects were conducted on slopes of potential winter habitat in the study area to evaluate mountain goat winter use of forested habitats near the proposed mine development area. Although many of the forested areas traversed by the transects appeared to meet the general criteria for suitable mountain goat winter habitat (old-growth forest, steep slopes, and near rock outcrop), there was no evidence that any of the areas surveyed had been heavily used by mountain goats (Cedar Creek Associates, Inc., 1991). The highest incidence of mountain goat pellets (9 pellet groups over two 810 yard transects) was recorded on the slope above the lower Kensington portal. The incidence of goat pellet groups in forested habitats in the vicinity of the proposed mine area indicates only minor use of these habitats by mountain goats. It is possible that mountain goats in the study area winter at higher elevations or in the more rocky areas that could not be traversed on the ground. It is also possible that past mining and exploration activities in the area have caused mountain goats to shift to habitats more distant from these activities.

A total of five mountain goats were radio-collared by the ADF&G in 1990 and an additional two in 1991 (LeMond, 1991). The five mountain goats captured in 1990 were all found to have contagious ecthyma. Mountain goats collared in 1991 did not show any evidence of the disease.

Relocations of collared mountain goats and aerial observations of associated animals during the winter of 1990/1991 has generally confirmed

mountain goat winter use of the slopes in the vicinity of Independence Lake (McCarthy, 1991a). During the winter of 1990/1991, mountain goats did not use the steep, timbered slopes above the Kensington portal, although the HSI model identified some of this area as potentially high quality winter habitat. (*See Figure 3-24, Mountain Goat Winter Habitat Capability*). Relocation data indicates that goats which include the mine area within their home range have larger home ranges than mountain goats that did not use the mine area. Also, these goats travelled farther to reach winter range (McCarthy, 1991b). This information is preliminary at this time. Additional data will need to be collected in order to test for significant difference between home range and movement patterns of mountain goats near the mine area and those that do not include the mine area within their home range.

Radio-collar monitoring of mountain goats will continue, at least, through 1993. ADF&G 1990 aerial surveys of the Lions Head mountain goat population indicates that roughly 70 mountain goats reside on the west side of Lions Head Mountain (McCarthy, 1990).

Hunter use of the Lions Head Mountain area for mountain goats is thought to be generally consistent from year to year but not extensive. On an average, approximately two mountain goats per year are harvested from this area (McCarthy, 1990).

Moose

Moose occur in a variety of habitats and are widely distributed in Alaska. Areas of successional shrub growth supporting alpine or riparian willows are preferred. During summer and fall, moose are found in areas supporting suitable browse from sea level to above timberline. In the winter snow accumulations force most moose to the lower elevation and constricted winter ranges.

Two transplants of moose calves were made in the Berners Bay area (ADF&G Unit 1C) in 1958 and 1960. A total of 21 moose were released into the area. The transplants were successful, and a limited hunting season for bull moose was established in 1963 (ADF&G, 1989a). Hunting has continued until the present except in 1975, 1976, 1977, and 1985 when moose hunting was closed. Recent ADF&G fall (1986) and winter (1989) aerial surveys counted 68 moose in the Berners Bay area. The moose population in this area is considered to be near the available habitat capability of an estimated 80 to 110 animals (ADF&G, 1989a).

Moose habitat in the Berners Bay area is generally associated with riparian vegetation where willow and black cottonwood provide the most abundant preferred forage. Moose winter range is associated with the valley bottom habitats comprised of willows, alders, and pioneer communities of alder, cottonwood and willow. The lowland portions of the Berners Bay drainage support important moose winter habitat, while the upland portions of this drainage represent important nonwinter habitats. (*See Figure 3-25, Moose Range*).

The project area occurs within the general distribution area of the Berners Bay moose population but is not located within important winter or yearlong range. Incidental observations of moose and moose sign (tracks and droppings) recorded during onsite surveys indicate that moose occasionally occur within the study area during the summer months. Observations of moose and moose sign were recorded primarily in the vicinity of Slate Creek Lakes and Independence Lake and in small isolated areas of muskeg. The relatively narrow, incised character of drainages within the study area limits the development of riparian vegetation preferred by moose, and extensive moose use of the project area is not expected.

Black Bear

Black bears eat both plant and animal matter but feed primarily on herbaceous vegetation and berries. They eat meat only when prey or carrion is readily available. The distribution, availability, and growth of key food plants are the primary factors affecting black bear habitat selection and movements (Reynolds and Beecham, 1980). Studies by Modafferi (1982) analyzed home range and movement of Southeast Alaska black bears in relation to food sources. He found that after leaving their dens black bears move to estuaries, beach fringes, and avalanche slopes where they forage on the shoots and new leaves of emerging vegetation.

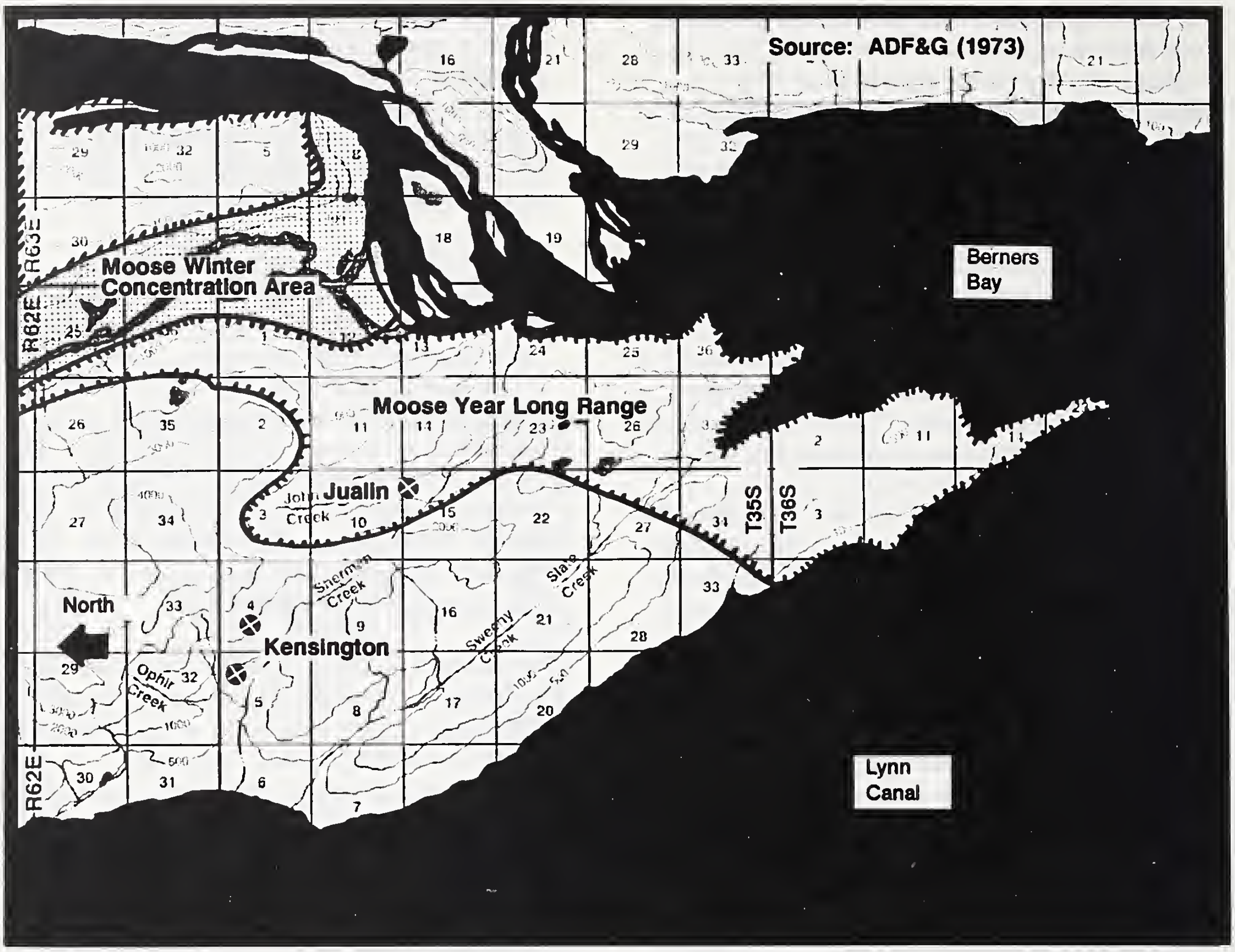


Figure 3-25, Moose Range

The bears move to the mid-elevations from mid-June to mid-July to feed on salmonberries and deer cabbage. By mid-July, if streams supporting runs of fish are available, black bears will feed on spawning salmon. However, by late August, bears will abandon a salmon food source to feed on salmonberries and blueberries at the higher elevations.

Black bears prefer a diversity of vegetation types but will not forage far from areas of suitable cover. Suitable cover is characterized as old-growth forest with a well developed understory. Bears den under deadfall, in caves, and in tree hollows. In Southeast Alaska, avoidance of surface moisture is an important factor in den site selection. Maximum populations of black bear occur in semi-open forests where there is a mixture of habitat types and an abundance of berry shrubs, herbs, grasses, and succulent forbs (ADF&G, 1973).

Availability of ample, suitable forage prior to the winter denning period is considered an important factor for black bear survival.

Black bear home range sizes can vary from as small as 0.5 square mile to more than 60 square miles. Extensive movements are often associated with males (especially during breeding season), with foraging activities, or with dispersal of younger animals (Pelton, 1987).

Population data for black bears in Game Management Subunit 1C or in the vicinity of the project area are not available. Based on habitat information contained within the Forest Service GIS database, the preliminary Habitat Capability model for Black Bear in Southeast Alaska (Suring et al., 1988b) predicts that the study area could support approximately 1 bear per square mile. Harvest data, reported sightings,

and nuisance complaints in the Juneau vicinity indicate that populations of black bear are relatively high in this region (ADF&G, 1989b). Densities of black bears determined by studies in other high bear population areas in Washington and Alaska range from approximately 1 to 1.5 black bears per square mile (McCarthy, 1990) and are consistent with model predicted population levels.

Within the project area, Kensington personnel sightings of black bear occur most often in avalanche chutes near the upper portal in the spring and during summer salmon runs in beach areas adjacent to the streams. A sow and two cubs also were sighted on several occasion along the lower portal access road during the spring and summer of 1989. Black bear sign (scat and tracks) was also frequently encountered during field surveys in hemlock/spruce forest habitat throughout the study area. Potentially suitable habitat for black bear within the study area was mapped based on the habitat capability model and habitat information contained within the GIS database. (*See Figure 3-26, Black Bear Yearlong Habitat Capability*).

Two black bears were radio-collared by the ADF&G in the fall of 1990 near Sherman Creek. One bear, a female, denned just above the lower portal in heavy timber. This bear was killed near Point Sherman by a hunter in the spring of 1991. A 1990/1991 winter den location was not found for the other bear, a male. This bear was seen near the mouth of Johnson Creek in the spring of 1991 and has since been relocated near Point Sherman and in the upper reaches of Sweeny Creek (McCarthy, 1991b). Six additional black bears were radio-collared in 1991. Monitoring of black bears will be used to verify the black bear habitat capability model.

Black bears are easily attracted by the presence of human food and garbage that is not properly stored and can become a nuisance around areas of human habitation. Once bears become accustomed to human garbage they are difficult to discourage and often have to be destroyed. In 1989, activities of one black bear resulted in its killing by Kensington personnel under the defense of life or property provisions of State game regulations.

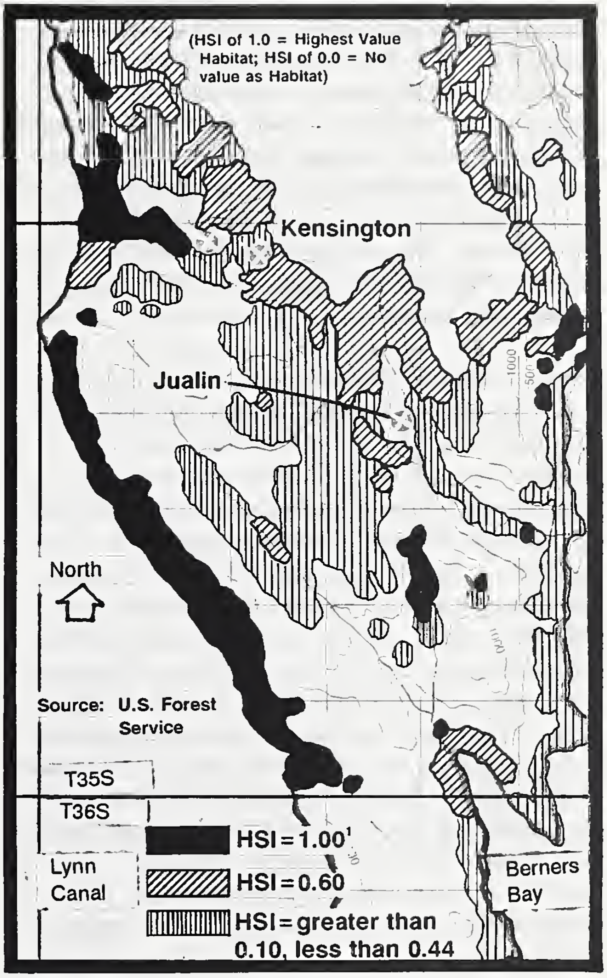


Figure 3-26, Black Bear Yearlong Habitat Capability

Brown Bear

Brown bears are indigenous to Southeast Alaska and occur throughout the mainland coast and on islands north of Frederick Sound. Much of the existing information on brown bear habitat utilization in Southeast Alaska has been gained through ADF&G studies initiated in 1981 on Admiralty Island (Schoen and Beier, 1989). For the most part, brown bear seasonal movements and use of habitats is similar to that described for black bear in the preceding section. After brown bears emerge from their high-elevation dens (higher than 1,000 feet) in April and May, they move to forage in low-elevation old-growth forests, coastal sedge meadows, or south-facing avalanche slopes. By mid summer, brown bears move up to forested slopes and alpine/subalpine meadows to forage on newly emerging vegetation. From mid July

through early September, most bears move to coastal salmon streams to feed on the anadromous fish runs. In late summer, brown bears again move up to higher elevation forests, subalpine meadows, and avalanche chutes to forage for currant and devil's club berries. Winter denning begins in October and November. Old-growth forest is used consistently throughout the year for feeding, cover, and denning.

The preliminary Habitat Capability Model for Brown Bear in Southeast Alaska (Schoen, et al., no date) predicts that suitable habitats for brown bear exists within the study area; however, brown bears are not expected to be common in the vicinity of the project site. In Southeast Alaska, the ranges of brown bears and black bears generally do not overlap (Morgan, 1989), and no brown bear intensive use areas are known to occur in the vicinity of the project area (ADF&G, 1973). Kensington personnel have reported only one sighting of a brown bear in the summer of 1988, but this may have been a cinnamon phase of a black bear. A set of what appeared to be brown bear tracks was observed by ADF&G personnel in April 1990 In the snowpack at approximately 2,800 feet in elevation above the upper Kensington mine portal.

FURBEARERS

Numerous furbearers are known to occur or could potentially occur within the project area. Two of the furbearers expected in the project area, gray wolf and wolverine (ADF&G, 1973), also are classified as big game by the ADF&G. Other potential inhabitants include mink, marten (*Martes americana*), river otter (*Lutra canadensis*), ermine (*Mustela erminea*), least weasel (*Mustela nivalis*), lynx (*Felis lynx*), red fox (*Vulpes vulpes*), coyote (*Canis latrans*), beaver (*Castor canadensis*), muskrat (*Ondatra zibethicus*), flying squirrel (*Glaucomys sabrinus*), and red squirrel (*Tamiasciurus hudsonicus*) (ADF&G, 1978). Due to the secretive nature and wide-ranging habits of many of these species, little specific information on distribution and population densities within the project area is available. Onsite field studies (Dames and Moore, 1989a, Cedar Creek Associates, Inc., 1991) have documented the occurrence of mink, river otter, ermine, marten, red fox, beaver, and red squirrel. Habitat for coyote, red fox, lynx, and muskrat in the project area is considered marginal (ADF&G 1978), and these species would be expected only infrequently on or near the project area.

Beaver, river otter and mink prefer habitats near water and occupy wetland or riparian habitats. No observation of beaver or of recent evidence of their occurrence with the project area were recorded. Old beaver cuttings were noted along the stream courses and at Slate Creek Lakes and Independence Lake. An old washed out beaver dam was found in Ophir Creek. An active river otter den was located at Independence Lake, and river otter sign (tracks and scat) was relatively common along beach fringe areas and steam courses. In southeastern Alaska, river otter are most abundant along coastal area where a diversity of food and nearby cover (forested areas) is available (Larsen, 1984). Using Forest Service GIS database habitat information, the preliminary Habitat Capability Model for River Otter in Southeast Alaska: Spring Habitat (Suring et al., no date) predicts that suitable habitats within the study area could support approximately 3.4 river otters per square mile. Stream courses within the study area are used by river otter for travel corridors and for foraging, especially during runs by anadromous fish. Mink, like otter, are found most often in association with freshwater and marine shore habitats.

In Alaska, marten distribution coincides with that of climax forests. This species prefers mature, moist coniferous or mixed forests with at least a 30 to 50 percent crown density (Koehler et al., 1975; Allen, 1982). They feed on a wide variety of foods including squirrels, voles, mice, birds, fish, reptiles, amphibians, insects, and fruits and berries (Clark et al., 1987), but voles are often cited as the marten's preferred food source (Koehler et al., 1975; Gordon, 1986). Based on habitat information contained within the Forest Service's GIS database, the preliminary Habitat Capability Model for Marten in Southeast Alaska: Winter Habitat (Suring et al., 1988c) predicts that suitable habitats within the study area could support approximately 1.7 martens per square mile.

No wolverines have been sited in the study area, but a few animals are trapped annually in the Berners Bay area (Morgan, 1988). Radio-tracking studies of wolverine in northwest Montana indicate that wolverines prefer rugged, relatively inaccessible mountainous areas at the high elevations in the summer and move to lower (but still snow-bound) elevations in the winter (Hornocker and Hash, 1981). Wolverines are adapted for carrion feeding and will take their food from carcasses of large animals such as deer and moose. Wolverines will also kill smaller prey such as snowshoe hare, marmot, and different species of small rodents. The scavenging lifestyle of wolverines results in seasonally long movements and relatively large home ranges (Hornocker and Hash, 1981). It can be assumed that a wolverine may occasionally pass through the study area in search of food.

Like the wolverine, gray wolves are typically wide-ranging. They are adaptable and capable of existing in a wide variety of climates, terrains, and habitats. The presence and survival of gray wolf is dependent on the availability of prey rather than landform, climate, or habitat. Within the project area, beaver, mountain goat, Sitka black-tailed deer, and moose represent the principal prey. Observations of gray wolf and wolf tracks indicate that wolf are occasionally found within the project area.

Kensington personnel have recorded only one observation of a single gray wolf within the project area. Scattered wolf tracks were noted in association with mountain goat tracks along the beach fringe between Point Sherman and Point St. Mary during the February 1989 aerial survey. Wolf tracks also were noted during this survey period along the road to the Jualin Mine in the Johnson Creek drainage to the east of the project area. The frequency of occurrence of gray wolf within the project area may be limited by the apparent low numbers of its preferred prey.

Trapper observations of wolves in the vicinity of the project area indicate that a pack of approximately 12 animals hunt the Slate Creek area, but their use of this area appears to have declined over the last 2 years (McCarthy, 1990).

Red squirrel and northern flying squirrel occur throughout boreal forests in North America. They are also known to occur in coniferous forests in the region of the project area. Within the project area, red squirrels were seen and heard frequently, especially in areas supporting large Sitka spruce trees. Based on habitat information contained within the Forest Service GIS database, the preliminary Habitat Capability Model for Red Squirrels in Southeast Alaska (Suring and Young, 1988) predicts that suitable habitats within the study area could support approximately 486 squirrels per square mile.

Optimum habitat for red squirrels provides opportunities for obtaining food, food caching sites, and nesting cover (Vahle and Patton, 1983). This species often uses logs or stumps for preferred feeding sites and nests in tree cavities or in dense branches. Old-growth Sitka spruce forests are believed to provide the most suitable features for optimum red squirrel habitat in Southeast Alaska. Old-growth western hemlock/Sitka spruce habitat (similar to the predominant habitat in the study area) is somewhat less than optimum (Suring and Young, 1988).

OTHER MAMMALS

Habitats within the project area support a variety of other small and medium-sized mammals. Many of the rodents and other small mammal species represent an important food source for raptors and mammalian predators. Specific information regarding population number and the distribution of most of these species is not available. However, some general conclusions related to species occurrence in the project area can be made based on known mammal distributions and habitats present within the study area. A discussion of potential inhabitants is contained in Cedar Creek Associates, Inc. (1991).

On the ground field surveys in 1990 only documented the presence of porcupine and hoary marmot. Porcupine gnawings on trees and pellets were frequently encountered throughout forested portions of the study area. Hoary marmots were commonly heard and seen on talus avalanche slopes and areas of rock outcrop near timberline. Habitat for snowshoe hare is considered marginal (ADF&G, 1978),

and populations of this species are not expected to be high on or near the project area. No observations of snowshoe hares, tracks, or pellets were made during any of the field activities.

WATERBIRDS

Waterbirds include waterfowl, shorebirds, seabirds, and other birds typically associated with wetlands and bodies of fresh and sea water. A variety of waterfowl, seabirds, and wading birds occur near the project area depending on the season. Lynn Canal is a major migration corridor for waterbirds with larger concentrations of birds migrating and staying in the area longer in the spring than in the fall. Species present primarily during migration include loons, horned and red-necked grebes, tundra swan, northern pintail, American wigeon, goldeneye, scaup spp., green-winged teal, black-bellied plover, black turnstone, western sandpiper, least sandpiper, short-billed dowitcher, and Bonaparte's gull, among others. Trumpeter swan is considered an uncommon fall and spring migrant in this region (Armstrong, 1990).

Berners Bay and the lower Berners River areas receive considerable nesting and molting use by waterfowl (ADF&G, 1973). Major nesting and molting areas within Berners Bay are the Cowee Creek flats and portions of the Berners, Antler, and Lace Rivers (NMFS, 1974). Potential freshwater breeders include Vancouver Canada goose, mallard, harlequin duck, merganser, and red-breasted merganser. Birds potentially nesting in or near the tidal flat areas within Berners Bay include semipalmated plover and black oystercatcher. Greater yellowlegs, spotted sandpiper, and common snipe are expected to nest in association with freshwater habitats such as muskeg, lakes, and streams.

Seasonal abundance of waterbirds in Lynn Canal and Berners Bay is dependent on food sources and climatic conditions. Large numbers often occur where small marine fishes (e.g., herring, capelin) or anadromous fishes concentrate. Large concentrations of glaucous-winged gulls and Arctic terns have been observed in association with schools of eulachon in Berners Bay in May (NMFS, 1974). Large numbers of scoters, harlequin ducks, mergansers, mallards, goldeneyes, and several species of shorebirds also have been noted in Berners Bay in May (NMFS, 1974).

No large nesting colonies of seabirds are known to occur in the vicinity of the project area (USFWS, 1978), and nesting by these species would only occur as scattered pairs or small colonies near the project area. Based on habitats present, possible nesters along the coastline near the project area include black oystercatcher, pigeon guillemot, and marbled murrelet. The marbled murrelet may be listed as threatened or endangered in the Pacific Northwest in the future (Holmberg, 1990). In Southeast Alaska, this species is found most often in marine waters of less than 50 fathoms deep and along steep, rocky coastlines (Quinlan and Hughes, 1984). It nests in trees in old-growth forest.

Five aerial (hellicopter) surveys were conducted during the spring migration and early nesting period to document numbers and distribution of waterbirds in marine habitats near the study area (King, 1991a). Surveys were conducted from April 15 to June 3, 1991 at approximate 10 day intervals except for the interval between the fourth and last survey which was longer due to an extended period of inclement weather.

For the April 15th survey, winter conditions still existed along nearshore habitats and the number of birds recorded was generally similar to the counts made during the winter 1990/1991 survey period. A greater diversity of species was recorded, however. On April 25 substantial snow cover remained above the high tide line in Berners Bay. The number of birds had doubled since the previous survey with most of the influx comprised of mew gulls and scoters (mostly surf scoters). Observed waterbird numbers peaked on May 5th with a tenfold increase from the April 25th survey.

Large concentrations of birds occurred near Echo Cove and the Berners River delta most likely in response to fish runs. Substantial gains in gulls (mostly mew gulls), surf scoters, grebes, harlequin ducks, mergansers, murrelets, and Arctic terns contributed to the increase. By May 15th the peak of the fish runs appeared to be over since there was a significant decline in the number of birds observed. Two-thirds of the

gulls and over one-half of the scoters had moved on. Numbers of mergansers and murrelets continued to increase, however. By June 3rd, the total number of almost all species had declined as adults moved on to nesting areas beyond the study area.

Bird species and numbers varied considerably between the Berners Bay portion of the survey area and the Lynn Canal coastline portion. In Berners Bay, waterbird numbers peaked on May 5th with over 80,000 birds counted. The majority of birds recorded were gulls (mew and Bonaparte's) with over 60,000 noted. Scoters (primarily surf scoters) were the next most abundant species recorded (over 10,000). Numbers of dabbling ducks (mostly teal, mallard, and wigeon) peaked on April 25th, although teal numbers remained relatively high through May 15th. Diving and sea duck numbers peaked by early May, but their numbers remained relatively high from late April through mid-May. Murrelet numbers increased throughout the survey period, and over 1,400 murrelets were counted within Berners Bay on June 3rd. The greatest concentrations of birds within Berners Bay throughout the entire migration period were noted in the vicinity of the Berners River delta and between Point Bridget and Echo Cove.

Along the Lynn Canal eastern coastline, from Point St. Mary to a point about 3 miles north of Point Sherman, total numbers of waterbirds and waterbird species were substantially less than those found within Berners Bay. On May 5th, when over 80,000 birds were recorded within Berners Bay, only 1,900 waterbirds were observed along the Lynn Canal coastline. Waterbird numbers for the Lynn Canal portion of the survey area peaked in mid-May at nearly 6,000 birds. By the June 3rd survey, total numbers recorded fell below 2,000. Predominant species along the coast were harlequin ducks, surf scoters, and gulls. Numbers of murrelets increased to a total of 268 birds on May 25th and then decreased to 97 birds on June 3rd. An increase in loons in late May suggested a migration along this coast. Few dabbling ducks and only relatively small numbers of other species such as grebes and mergansers were noted along the coastline. Waterbird distribution along the coastline was very dynamic from April 15th to June 3rd, and no consistent pattern of bird concentrations was discernible from the survey data.

On the ground field surveys recorded the presence of only a few waterbirds in freshwater habitats in the study area during May and June 1990 field periods, and these were only noted in the Slate Creek Lakes area. No waterbird use of Independence Lake was documented. Observations were made of Vancouver Canada geese (numerous), ring-necked duck (1 pair), greater yellowlegs (1 pair), and a pair of unidentified young diving ducks.

The Slate Creek Lakes area appears to receive extensive summer feeding and probably molting use by Vancouver Canada goose. A group (105) of geese noted during the May 1990 survey period were most likely non-breeding adults. Another group of 75 Vancouver Canada geese were observed on Slate Creek Lakes by USFWS personnel in lat July, 1991 during a fixed-wing overflight (King, 1991b). In the region of the project area, Vancouver Canada geese most typically nest along the beach fringe within 100 yards of the marine shoreline (Isleib, 1990). Late spring snow cover likely limits goose nesting use of more upland habitats such as the Slate Creek Lakes area.

Vancouver Canada goose use of the survey area for spring migration and nesting appeared to be relatively minor based on the number of birds observed during the spring aerial surveys. The largest number of geese (51 Canada and 250 white-fronted) was recorded by the April 25th survey. During the remainder of the surveys, only six to 10 Vancouver Canada geese were observed within Berners Bay, and none were recorded along the Lynn Canal coastline or in the Slate Creek Lakes area.

Berners Bay and Echo Cove east are known to support concentrations of wintering waterfowl and seabirds. Wintering by waterfowl along the open water portions of Lynn Canal is limited by its open exposure to storms and winds. Several species of diving duck (goldeneyes, scoters, mergansers, harlequin ducks, buffleheads, among others), mallard, and Vancouver Canada goose over winter in the region. Other wintering species expected are rock sandpiper, mew gull, herring gull, glaucus-winged gull,

common murre, pigeon guillemot, and marbled murrelet.

Aerial seabird surveys conducted in December, 1990 and January, 1991 (King, 1991a), recorded mallard, surf scoter, goldeneye, buffflehead, and mew and glaucus-winged gulls as the most abundant species within Berners Bay. Grebes, loons, harlequin ducks, oldsquaws, and mergansers also were recorded but in relatively small numbers. The most abundant species recorded along the coastline near the project area by the same survey were harlequin ducks and mew and glaucus-winged gulls.

Within Berners Bay, the greatest concentrations of seabirds and waterfowl were observed between Echo Cove and Point Bridget (954 birds out of a total of 1,454 in December; 2,850 out of a total of 3,456 in January). Birds (predominantly gulls; 1,056 out of a total of 1,503 in December; 744 out of a total of 1,075 in January) along the Lynn Canal coastline were more uniformly distributed. Here the largest numbers of birds were recorded in a 2-mile survey segment approximately 2 miles north of Point St. Mary and in a survey segment encompassing a 2-mile stretch of coastline at Point Sherman. In January there was a general shift toward a greater percentage of birds in the Point Sherman area.

In December, small numbers of marbled murrelets were recorded in Berners Bay (8) and along the coast near Point Sherman (16) by the winter aerial waterbird survey conducted in December, 1990. None were observed in the survey area in January, 1991. The greatest number of marbled murrelets (14) were recorded primarily in the northern-most survey segment, approximately 1 mile north of Point Sherman.

RAPTORS

Bald eagle and red-tailed hawk were the only raptors observed within the study area. The peregrine falcon, which may occur in the area is discussed in a subsequent section, *Threatened and Endangered Wildlife Species*. Bald eagles are common residents of Southeast Alaska and are known to nest along the coastline near the project area. (See *Figure 3-27, Bald Eagle Nest Sites*). Bald eagles were frequently observed during field surveys in hemlock/spruce habitat near the coast. In Southeast Alaska, bald eagles typically nest in large Sitka spruce trees in stands of old-growth timber within 200 meters of salt water (Hodges and Robards, 1982).

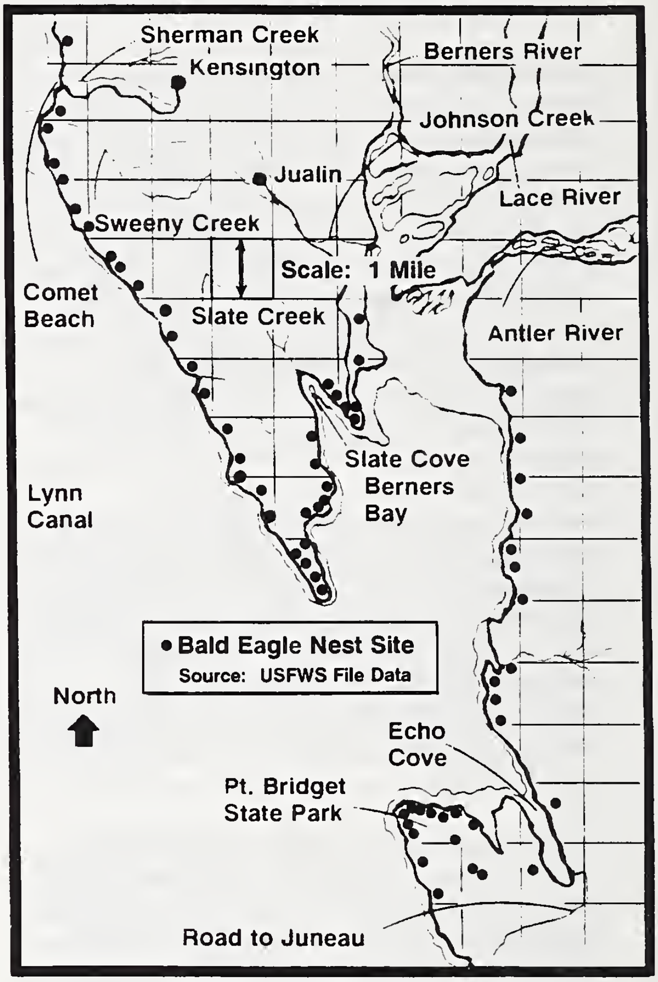


Figure 3-27, Bald Eagle Nest Sites

Nesting by red-tailed hawk is expected within the study area. Single adults were observed over forested habitat on two occasions during May 1990, and a pair of vocalizing adults were noted in flight over the Slate Creek Lakes area in June 1990. Red-tailed hawks typically nest in relatively large trees with open crowns or on cliff ledges and areas of rock outcrop. No red-tailed hawk cliff or tree nest sites were located in the study area.

Other potential breeding raptors are discussed in Cedar Creek Associates, Inc. (1991).

GAMEBIRDS

Blue grouse, willow ptarmigan, rock ptarmigan, and white-tailed ptarmigan are known to occur in the project area region. All occur as year-long residents. Field studies documented the presence of blue grouse and rock ptarmigan. Blue grouse were common throughout the forested portions of the study area. During spring and early summer field periods, blue grouse were heard or seen along the majority of transects in hemlock/spruce habitat. Often several individuals were heard along a single transect. Blue grouse prefer areas of coniferous forest with an understory of shrubs. Forbs and the leaves and fruits of shrubs are principal food items for adult birds during the summer months, while conifer needles and buds comprise the majority of their diet in the winter.

Willow ptarmigan is the most widely distributed ptarmigan in Alaska. It breeds close to timberline at the edge of forests. Willow ptarmigan prefers wetter areas than the other two ptarmigans. Its primary sources of food are the leaves, buds, twigs, and catkins of willows. Preferred breeding habitat of rock ptarmigan is rocky areas with scattered shrubs and herbaceous vegetation from timberline to 3,500 feet in elevation. White-tailed ptarmigan occur in rugged, sparsely vegetated areas above timberline from 3,500 to over 5,000 feet in elevation.

OTHER AVIFAUNA

A variety of songbird and other avian species associated primarily with spruce/hemlock coniferous forest occur in the study area. Most occur as migrants or summer residents with only a few species remaining in the region during the winter months. Common birds documented in hemlock/spruce forest habitat in the study area during spring and early summer were dark-eyed junco, winter wren, varied thrush, and ruby-crowned kinglet. Hermit thrush, American robin, golden-crowned kinglet, Steller's jay, yellow-rumped warbler, and chestnut-backed chickadee also were noted in hemlock/spruce forest but less frequently. Orange-crowned warbler, white-crowned sparrow, and rufous hummingbird were commonly found in alder shrubland or near the edges of hemlock/spruce forest.

AMPHIBIANS

Boreal toad was the only amphibian documented within the study area during spring and early summer field surveys. Young boreal toads were abundant in the tall sedge/grass meadow and muskeg habitats around the perimeter of Independence Lake, especially where mosses formed a thick ground cover. Boreal toads generally prefer open, nonforested areas and breed in muskeg ponds, streams, and temporary pools.

The spotted frog is rare in Alaska and is being considered for threatened or endangered listing in the Pacific Northwest. This species is highly aquatic and is rarely found far from permanent rivers, streams, and lakes. It frequents grassy margins of still or slow-moving waters. There is limited suitable habitat for this species along Sherman or Sweeny Creek.

THREATENED AND ENDANGERED WILDLIFE SPECIES

Three species, American peregrine falcon (endangered), humpback whale (endangered), and Steller sea lion (threatened) are known to occur within the region of the project area. However, no known critical habitat for any state or federally listed threatened or endangered species occurs within the project area.

The American peregrine falcon (*Falco peregrinus anatum*) is listed by the U.S. Fish and Wildlife Service and Alaska as endangered and may migrate through Lynn Canal, although this subspecies is more often associated with interior Alaska.

The non-migratory Peales' peregrine falcon (*Falco peregrinus pealei*) is not endangered, but has been placed by the Forest Service on the Alaska Region Sensitive Species List. This species is known to nest in Southeast Alaska, and the USFWS has a 1975 nesting record for this species in Lynn Canal (location unknown) (Holmberg, 1990).

An ADF&G observation of an unidentified falcon over the project area in April, 1990 was possibly of this species. The peregrine's preferred nest site is a rugged, remote cliff usually overlooking water or marshy areas where avian prey is

abundant. June 1990 aerial and ground surveys and Forest Service 1991 surveys did not locate any evidence of nesting peregrines within the study area. Areas of rock outcrop or cliffs within the study area are confined predominantly to the elevations above timberline and are unsuitable for nesting due to late snow cover. In addition, most lower elevation rock faces within the study area did not appear to support ledges or cavities suitable for nesting activity.

Humpback whales feed in southeastern Alaskan waters from about May through December. They range from Dixon Entrance northward but are not uniformly distributed (Kreiger and Wing, 1984). Important feeding areas include Glacier Bay and adjacent portions of Icy Strait, Frederick/Stephens Sound, and Seymour Canal (Perry et al., 1985). Lynn Canal may also be an important area for humpback whales, but its use by humpbacks needs to be evaluated (Perry et al., 1985).

Humpback occurrence in Lynn Canal is variable, but they are common in some years (Nanney, 1990). Their occurrence is most likely related to the presence of concentrations of small fish. Humpback whales have been observed feeding off of Point Sherman usually from April through June (Nanney, 1990). ADF&G biologists conducting research on coho salmon in Berners Bay during the summer occasionally observe humpbacks in Lynn Canal, but not within Berners Bay (Shaul, 1990). Individual humpback whales also have been observed occasionally in waters near the project area from aerial transport flights to and from the project area. A Biological Assessment of this species is contained in *Appendix B*.

The Steller sea lion was listed as a threatened species on November 26, 1990 (55 FR 49204). Steller sea lions occur throughout coastal Alaska from Southeast Alaska to the Bering Sea. Sea lions use specific land-based sites as locations for resting, breeding, and the rearing of young. Places used only for resting are referred to as "haulouts," while sites used for breeding and rearing young are called "rookeries." Sea lions are gregarious and large groups often use traditional haulout and rookery sites. These sites are typically located on remote offshore islands. The majority of identified haulout and rookery sites in Alaska are located on islands in the Gulf of Alaska and the Aleutian chain.

Only four known rookery sites are located in Southeast Alaska. One is on Forester Island (Hoover, 1988; Loughlin et al., 1984), located in the Gulf of Alaska to the northwest of Dixon entrance. Two others are Hazy Islands and White Sisters near Sitka (Pennoyer, 1991). The fourth rookery is located on the western shore of Lynn Canal approximately 2 miles north of Yeldalgalga Creek (Rusanowski, 1991). All are remote from the project site.

Exact numbers of sea lions at any location cannot be determined with certainty (Hoover, 1988). Counts made at haulouts and rookeries represent minimum estimates since animals at sea are not accounted for. No population estimates are available for Lynn Canal, but Loughlin et al. (1984) reported a population of 8,000 to 12,000 Steller sea lions for Southeast Alaska.

Haulout areas for Steller sea lions are known to occur on Benjamin Island 22 miles southeast of the project area (Mello, 1990); the east coast of Lynn Canal approximately 4 miles north of Point Sherman (Staska, 1990; Stein, 1991), and at two sites at the north end of Lynn Canal, Point Seduction (Bruce, 1990) and the coast east of Flat Bay (Nanney, 1990). Small numbers of Steller sea lions also have been observed hauled out along the coast about 5 miles south of Point Sherman in May (3 to 4 sea lions) and from the Slate Creek Cove area south to Point St. Mary in the spring and summer (15 to 20 sea lions) (McCarthy, 1990). It is expected that individual and small groups of Steller sea lions will occasionally occur foraging in or moving through the offshore waters in the vicinity of the project area. Sea lions are commonly observed in the Point Sherman area by gillnetters during the summer months (Nanney, 1990; Bruce, 1990). Four sea lions were observed approximately 100 meters offshore swimming past the access point to the project site in May 1990. A Biological Assessment of this species is contained in *Appendix B*.

RECREATION

This section deals specifically with non-urban types of recreation. Urban recreation activities are discussed in the *Socioeconomics Section, Chapter 3.*

The Tongass National Forest provides a distinctive living environment for local residents and a variety of unusual vistas and recreation opportunities for visitors. "The residential and visitation experiences in Southeast Alaska are inextricably linked with the Tongass, so that management decisions on the forest influence many, (if not most), benefits of living and visiting there," (Randall, Hoehn, and Swanson, 1990).

RECREATION MANAGEMENT

The study area addressed in this section is largely National Forest System lands and therefore subject to Forest Service management. The Forest Service uses an inventory process called the Recreational Opportunity Spectrum (ROS) to categorize the recreational resource on a forest. ROS is the basis for integrating recreation into the overall land and resource management planning process and for management actions.

Recreation opportunities are composed of three principle components: the activities, the setting, and the experience. The ROS is based on six recreation classes, from Primitive, at the wilderness end of the spectrum, to Urban. Each ROS class has its own management implications. Once the ROS is defined and mapped for a forest, the classifications help guide management actions to assure that visitors will have the kind of recreational experience they expect for an area (USDA Forest Service, 1982).

In the general study area (from northern Berners Bay up the east coast of Lynn Canal to the project site), the ROS classes are primarily Semi-Primitive Non-Motorized (SPNM) and Semi-Primitive Motorized (SPM). *(See Figure 3-28, Recreational Opportunity Spectrum Map).* Examples of the activities, settings and experience characterizations for these two ROS classes are provided in *Table 3-13, Recreational Opportunity Spectrum Components.* Specific additions or exceptions may occur depending on local forest situations.

EXISTING RECREATION SITUATION

Current recreational use of the study area can be broken into two main categories -- nonresident (tourism) or resident.

Nonresident Recreation

The tourism industry in the area is shaped primarily by the remote location and lack of overland transportation to much of the Tongass National Forest. Most visitors arrive by cruise ship or air. "As a result, they are more dependent on tour packages and guide services, and are generally less able to engage in 'do it yourself' trips" (USDA Forest Service, 1989). Nonresident recreational use of the Tongass National Forest is characterized by day visits. Only 11 percent stay overnight (USDA Forest Service, 1989).

Tourist activities are primarily related to wildlife resources and the area's outstanding visual character. Two thirds of Southeast Alaska's 350,000 annual visitors come for the scenery (USDA Forest Service, 1989). Tourism in Southeast Alaska has increased from 5 to 10 percent per year in recent years.

There is documented evidence that some tourists do recreate in the general area near the project site. The largest number of nonresidents are exposed to the proposed mine site from cruise ships or the Alaska Marine Ferry. The ship route is from 1 to 2 miles offshore, in Lynn Canal.

Ship passengers can view the Kensington Project area for approximately 10 minutes (Lippitt, 1990). The Forest Service has interpreters aboard the Alaska Marine Highway System Ferries during the summer months. Mining and mineral resource management is one of 15 to 20 subjects currently covered in the Forest Service's Shipboard Interpretive Program (Lippitt, 1990). Private cruise ships also have interpreters aboard.

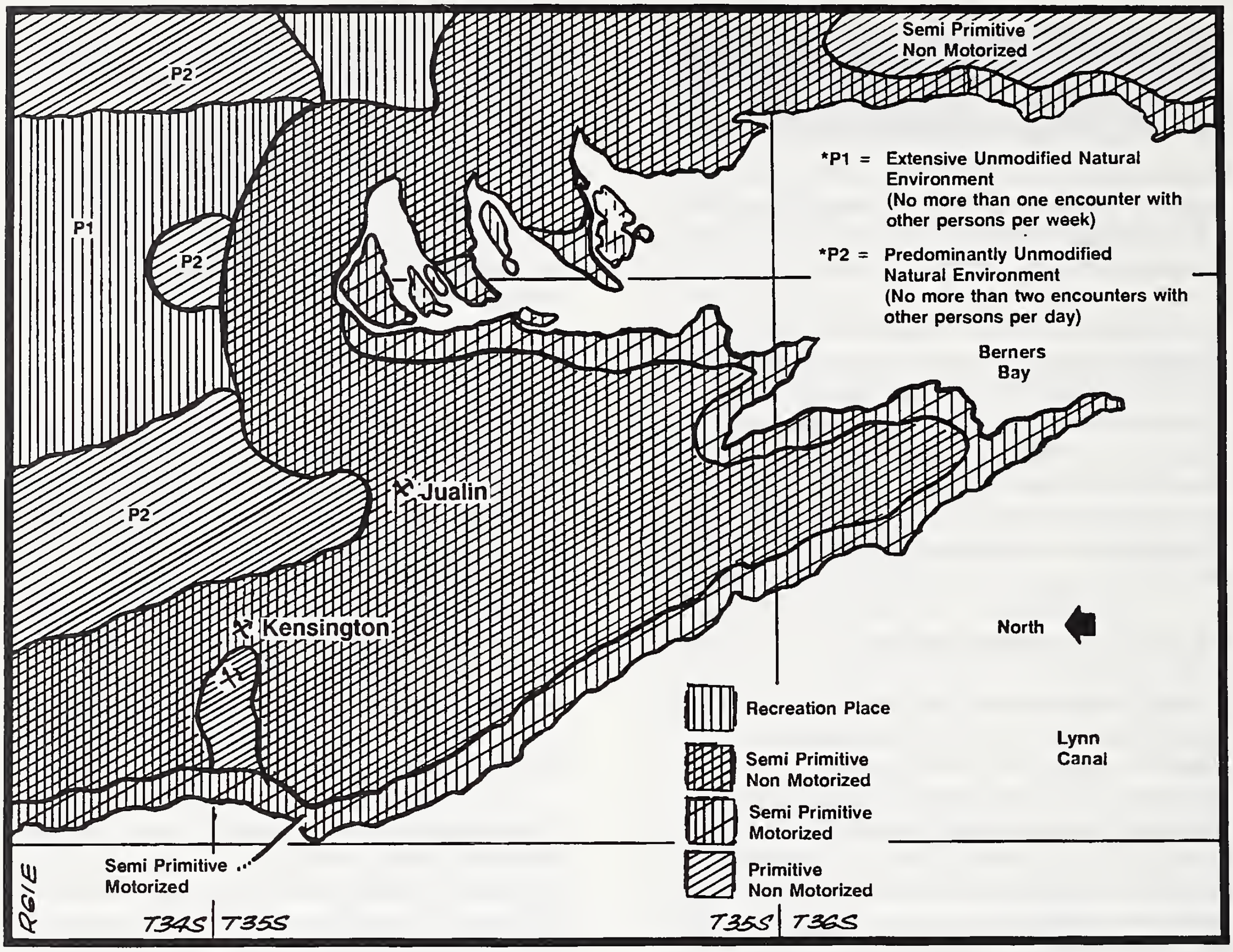


Figure 3-28, Recreational Opportunity Spectrum Map

Nonresidents have direct contact with the study area through several other popular activities. Wildlife viewing, "flightseeing," and the easy access to the study area from Juneau bring nonresidents to Berners Bay. The Alaska Department of Fish and Game currently is completing a report on nonhunting wildlife activities for the 1989 season. While the information is not yet available in a report, its author said some general information is available about the Berners Bay area. This area is a high use area compared to the Southeast Alaska coast in general. A number of non-guided tourists make 1 to 2 day trips to the area, often renting sea kayaks in Juneau. They come for the good access to wildlife -- whales, seals, sea lions, salmon, etc. (Shea, 1990).

Flightseeing is a popular activity in the summer over the Juneau icefields. Both helicopters and fixed-wing aircraft bring tourists for a close up view of glaciers and wildlife. Due to the long daylight hours, many flightseeing tours occur as late as 9 to 10 p.m. (Shramm, 1990).

One outfitter has a U.S. Forest Service permit to use the area for commercial trips (Humphrey, 1990). On average one kayak class is offered each month from the end of April to the beginning of October. Each class has 10 to 12 persons who spend parts of two days and one night learning to kayak in Berners Bay. The outfitter also guides one to two camp groups from other states each summer on 3-day trips in Berners Bay. The groups often camp on the west side of the bay from Slate Cove to Point St. Mary, where whale watching is a prime activity (Leghorn, 1990).

Table 3-13, Recreational Opportunity Spectrum Components

ROS Class	Activity	Experience	Setting
Semi-Primitive Non-Motorized (SPNM)	**Land Based:** • Viewing scenery • Specialized land craft • Aircraft • Hiking • Horseback riding • Camping • Hunting • Nature study • Mountain Climbing **Water Based:** • Power boats • Canoeing/kayaking • Sailing • Swimming • Fishing **Snow/Ice Based:** • Ice and snow craft • Downhill skiing • X-country skiing • Snowshoeing	There is a high probability of experiencing isolation from the signs and sounds of humans. Users experience independence, closeness to nature, tranquility and self-reliance through use of woodsman and outdoor skills in an environment offering challenge and risk.	The area is a predominantly natural environment of some size. Interaction between users is low, but there is often evidence of other uses. The area may be managed with minimum onsite controls and restrictions. Motorized use is not permitted.
Semi-Primitive Motorized (SPM)	**Land Based:** • Viewing scenery • Viewing works of humans • Automobiles • Train and bus touring • Train and bus touring • Aircraft • Bicycling • Camping • Picnicking • Resort/commercial svcs. • Recreation cabin use • Hunting • Gathering forest products • Interpretive services **Water Based:** • Tour boat and ferry use • Power boats • Canoeing/kayaking • Water skiing/water sports • Fishing **Snow/Ice Based:** • Ice and snow craft • Ice skating • Sledding/tobogganing • Down hill skiing • X-country skiing • Snowshoeing	There is a moderate probability of experiencing isolation from the sights and sounds of humans. Users experience independence, closeness to nature, tranquility and self-reliance through use of woodsman skills in an environment offering challenge and risk. The opportunity exists to use motorized equipment in the area.	The area is a predominantly natural environment of some size. The concentration of users is low, but there is often evidence of other users. The area may be managed with minimum controls and restrictions. Motorized use is permitted.

The outfitter reports that in 1990 from June to September, 40 percent of his kayak rentals (some 70 rental transactions) had Berners Bay as a destination. Both local residents and people from out-of-town rented kayaks with out-of-towners accounting for about 60 percent of the rentals (Alaska Discovery, 1991).

A number of Canadians travel to Haines to sport fish. Approximately 60 percent of the roadside anglers and 40 percent of the marine anglers are Canadian. A number of these fishermen will motor down to Sullivan Island and the area adjacent to the Kensington Project to fish for halibut (Rusanowski, 1991).

Resident Recreation

Residents of Southeast Alaska spend much time recreating on the Tongass National Forest. "Local residents make up 2.2 million of the 2.8 million visitor days that occurred in recent years on the Tongass" (USDA Forest Service, 1989).

Most of the recreational use of the forest occurs in favorite recreation places along shorelines, lakes, and rivers. On the Tongass, 1,300 recreation places, comprising about 4.8 million acres have been identified. Many of these places, including Berners Bay, are primary recreation designations of community residents (USDA Forest Service, 1990a).

Residents' use of the Berners Bay area appears to be much greater than along the less protected waters of Lynn Canal. The primary recreational activities occurring in the general study area include water based recreation, dispersed camping associated with boating, nonsubsistence hunting and fishing, recreational cabin use and visitors to Point Bridget State Park.

A public survey of recreational use of the study area was done in late 1990 and early 1991 by placing surveys in six public places and by distributing them to interest groups such as the Audubon Society and a kayaker's club. Of the persons who responded to the survey, nearly all said they participated in a number of different activities in the Berners Bay area. The greatest number of people said they fish in the area. Almost an equal number said they watch wildlife in the area. The third most popular activity among respondents was camping. Sightseeing, beachcombing, kayaking, canoeing, skiing, and motor boating also were reported as popular activities. Other recreational activities reported for the Berners Bay area were hiking, photography, collecting edibles, mountaineering, camping on a boat, using a cabin, hunting big game, hunting waterfowl, snowshoeing, airboating, trapping, and snowmobiling (Beck & Baird, 1991).

Water based recreation is popular in the Juneau area. The U.S. Coast Guard reports that of the 30,000 current valid boat registrations statewide, approximately 3,500 are from the Juneau area. There is no breakdown by pleasure or commercial boat categories (Simonson, 1991). One estimate is that one of every 15 people in the Juneau area has a boat (Bethers, 1990). Access to Berners Bay is by a road and paved boat ramp built with funds from Alaska Department of Fish and Game in the summer of 1990 at Echo Cove, a traditional launching site for small boats. The boat ramp was built primarily in response to public comment asking for one at Echo Cove (Bethers, 1990).

The easy access and protected waters of Berners Bay make it a popular place for Juneau residents to sea kayak and use skiffs and other small power boats. Kayaker use is seasonal with estimates ranging from about six individuals to six groups of kayakers on summer weekends (USDA Forest Service, 1988).

The Juneau Harbormaster maintains the new boat ramp, in Echo Cove including emptying the portable toilet and dumpster. For the month of August, maintenance records (Clauder, 1990) for the facilities indicate that as many as 20 people per day may have visited the area.

The launch site has parking for about 100 vehicles. The road was undergoing construction for much of the 1990 summer season, so the maintenance staff believes use of the site was lower than if the road had been in good condition. From October 1 to about April 1 the site is not maintained. During these months, the road is not plowed to the launch site, although some persons with four-wheel drive use the launch site, as long as they can get their vehicles through (Clauder, 1990).

Airboats are common in Berners Bay. Anglers, hunters and persons going to five special use cabins account for most airboat use. While some airboats are launched at Echo Cove, many are launched from the more developed Amalga Harbor about 10 miles south, toward Juneau (Clauder, 1990).

Some of the noncommercial fishing and hunting use of the area is documented, but not necessarily quantified. The ADF&G regularly does creel surveys at roadside fishing areas. Echo Cove and Cowee Creek are included in those creel surveys. While it is difficult to find any trends in the data, they do show significant fishing use of the area (Bethers, 1991). Because of the newly constructed boat ramp at Echo Cove, the ADF&G will start sampling for fishing boat use this year as is done in other boat harbors (Suchanek, 1991).

The Berners Bay area is a popular hunting area for Juneau residents. Black bears, brown bears, mountain goats, and moose are the most hunted big game animals. ADF&G reports total harvest numbers and effort by successful hunters, but no data are available on the total big game hunting effort.

Between 1981 and 1990, 70 black bears were taken in the area from Independence Lake to Echo Cove and lower Cowee Creek. The successful hunters were in the field an average of about 2.3 days per bear harvested. Ten of the successful hunters were nonresidents. In the same year, 15 brown bears were killed in the area with three taken by nonresidents. Hunting effort for successful hunters was 2.8 days per bear (McCarthy, 1991c).

In the period 1986 through 1990, 14 mountain goats were taken in 39 days of hunter effort. Permits for moose are drawn in a lottery. In 1989, five permits were drawn from a pool of 363 applicants. All five hunters were successful. Trapping for furbearers occurs in the area with beaver, otter, wolves, and wolverines being taken primarily from the area between Slate Creek Cove and Cowee Creek (McCarthy, 1991c).

Other existing recreational use of the area occurs at Point Bridget State Park and at a church camp adjacent to the state park. The state park allows dispersed camping. The legislation creating the park says it shall remain natural so, although some recreational development may occur, it will not be intensively developed (Gary, 1990).

Some of the recreational development at Point Bridget State Park has occurred recently. About 8 miles of trail were completed in summer 1989. Construction of a public use cabin is proposed when funding is available (Gary, 1990).

A parcel of private land in the general area is owned by a Native corporation, the Goldbelt Corporation. A proposed land trade with the Tongass National Forest is under consideration; however, Goldbelt still would retain private ownership on some land bordering Berners Bay. The corporation has no definite plans for the land at this time (Dwyer, 1990).

CULTURAL RESOURCES

PREHISTORY

Knowledge of the prehistory of southeastern Alaska is continuously evolving and still a subject of debate. Much site specific data exists only in unpublished form at this time. However a recent attempt at a comprehensive cultural chronology has identified several distinct prehistoric periods (Davis, 1990).

A Paleomarine tradition (9000 to 4500 B.C.) has been suggested to define the earliest cultural representations (Davis, 1990). Early recognized occupations of southeastern Alaska have been dated as early as 8200 B.C. from a multicomponents site on an elevated terrace at Ground Hog Bay (Ackerman, 1968; 1974). Small core, blade tools, and predominantly unifacial tools indicate some similarity with the complexes of the American Paleoarctic tradition. The lower levels of the large multicomponent site at Hidden Falls on Baranoff Island have also produced dates of 8000 B.C. in association with similar technology coupled with faunal (animal) remains suggesting coastal marine subsistence (Davis, 1989). Chuck Lake, a now-interior site, has yielded dates as old as 6300 B.C., and a

preserved animal collection including shellfish, sea mammals, and land mammals (Davis, 1990).

While it can be assumed that such early sites may occur elsewhere and usually in association with uplifted terrace environments, there is not enough data to confirm the frequency or type of settlement pattern. The general paucity of organic remains from these early sites discourages speculation about ancient subsistence strategies, although the location of some faunal elements in recently-tested sites suggest a coastal lifeway orientation.

A transition stage (4500-3000 B.C.) as been hypothesized following the Paleomarine tradition. This may actually be a partial cultural gap, however, new site discoveries may fill this void (Davis, 1991). There are few known sites with dates that fall within this time period, and these time assignments are subject to further refinement. Faunal information is lacking. The only artifacts found to date suggest either very little about tool types or appear to be a carry-overs of lithic technology from the earlier Paleomarine tradition (Davis, 1990). Further work may eventually explain this diachronic gap.

Beginning about 5,500 years ago, occupation sites arose along the immediate coast near the mouths of productive anadromous fish streams or adjacent to important marine resources. This pattern likely continued into historic times, although diachronic population and cultural restructuring over such a long time period would have been the rule rather than the exception (Fladmark, 1982). The general coastline, barring local glacial oscillations, and sea level became relatively stable certainly by 5000 years ago (Fladmark, et al., 1990). The Developmental Northwest Coast stage is distinguished from the earlier periods by shell middens; ground stone and bone technology; human burials; and later, the establishment of larger settlements of winter use, specialized subsistence encampments and fortifications (Davis, 1990).

This stage of cultural development has been further subdivided into three lengthy phases of eventual refinement. The Early phase (3000 to 1000 B.C.) provides evidence of the initial use of ground stone and bone tool industries. There is no continuation of the previous microlithic technology. Many wood working tools, such as adze, are also notable (Davis, 1990).

Widespread use of ground stone coupled to heavy reliance on unilaterally barbed bone points defines the Middle phase (1000 B.C. to 1000 A.D.). Also critical is the use of nephrite (jade) in tool making, ground burins, toggling harpoons, and possibly diminutive chipped stone projectile points or end blades (Davis, 1990).

The Late phase (1000 A.D. to cerca 1700 A.D.) continues much of the same technology with the addition of native copper, stone vessels, and the increased use of obsidian. In the Late phase the development of large villages and defensive fortifications arises (Davis, 1990).

Evidence for Tlingit ethnicity appears to be within this Late phase and has a time depth of a few centuries before White contact. The distribution of Tlingit sites can be expected to coincide with locations of known historic villages, as these Alaska Natives were widely established throughout this part of Southeast Alaska. Temporary, task specific small sites may be associated with inland hunting or gathering and overland travel. Unfortunately, such sites are ephemeral by nature and usually so small that they are easily masked by vegetation.

LATE PREHISTORY AND PROTOHISTORY

It is the more recent prehistoric and early Contact Period coastal localities of the Tlingit, marked by the introduction of drift iron for tool manufacture, that are best known. Berners Bay was the traditional territory of the Auk' Tlingit at the time of contact. Berners Bay is known for at least three permanent village sites and places of recorded petroglyphs (Alaska Heritage Resource Survey, 1986; Arndt, Sackett, and Ketz, 1987). These are Antler Bay Village (49-JUN-059), Berners Bay Village and petroglyphs (49-JUN-062), and Slate Creek Village (49-JUN-013). Four additional village sites plus a petroglyph location and a burial site are also noted for Berners Bay, but the location of each has not yet been confirmed (Arndt, Sackett, and Ketz, 1987; Sealaska Corporation, 1975). Known and reported site locations are not

surprising in light of ethnohistoric evidence for fishing, hunting, and berry picking at Berners Bay (Goldschmidt and Haas, 1946).

HISTORY

The Historic Period (Stone and Stone, 1980) begins with the explorations of Europeans to discover new lands and seek valuable furs. The discoveries of gold at Windham Bay in 1869 and later in Juneau in 1880 brought dramatic change to the previous maritime way of life of the Tlingit.

It is the area's historic mining sites that make up the remainder of the known cultural resources in the Kensington Project area. The Kensington Project is located in the northern extension of the Juneau Gold Belt, a mineralized zone that was subject to extensive mining and development between 1890 to 1910. Except for periodic prospecting ventures, activities had ceased completely by the early 1920s. At least 15 other mines once operated within a 5 mile radius of the Kensington Project. *(See Figure 3-29, Historic Mining Activity)*.

Gold was first discovered at the mouth of Sherman Creek about 1896. By 1900, Seward City was established at the location. As lode mining developed and expanded at the higher elevations of the Sherman Creek basin, Seward City became the landing terminus for supplies delivery and for loading milled ore on ships. A wharf adequate to accommodate these vessels was built. A narrow gauge railroad ran from the wharf to the Berners Bay Mining and Milling Company mill, which was located on Sherman Creek less than 2 miles from the landing. A general store began operations by 1901.

Mining intensity was quite short lived, however. Seward City was almost deserted and was renamed Comet, as a re-established but short-lived company town. A lien was put on all property, equipment, mines, claims and other interests forcing a bargain sale of all assets of the mining operations and town in 1910.

An equally short-lived resumption of mining activities started up again in 1915 by the Hayden-Stone Interest that controlled the claims. Restoration of the wharf, buildings, tramways, hydroelectric facility, milling plant, concentrate storage and loading facility began in 1916. These renovations were curtailed by the entry of the United States into World War I.

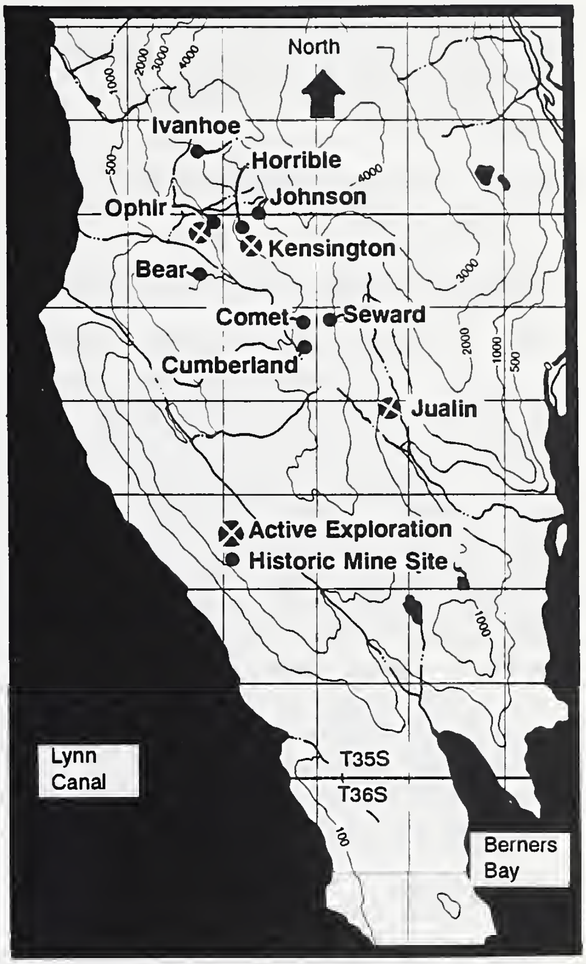


Figure 3-29, Historic Mining Activity

In the mid-1930s, the Kensington Mine and associated claims and improvements were acquired by the Alaska-Kensington Gold Mines Inc. During 1936, a road from the wharf to the mill was completed along with other facilities restorations.

An Alaska Territory tax on the gross production of precious metals that was devised in 1937 discouraged further investment at the mine. This hiatus extended through World War II.

Rejuvenated interest in the mine began in 1980 when Placid Oil company gained control of the patented and unpatented claims and associated structures. Exploration by Placid proceeded during the early through mid-1980s.

in 1987, Coeur Alaska, Inc, a subsidiary of Coeur d'Alene Mines Corporation, acquired the Kensington properties and formed a joint venture with Echo Bay Exploration Inc. to explore and develop the site. Known as the Kensington Venture, this exploration activity has conducted underground testing of the mineralized zone.

KNOWN CULTURAL RESOURCES IN THE PROJECT AREA

Prehistoric/Historic Alaska Native Sites

Of the several known and reported cultural resources around Berners Bay, only one site (49-JUN-013) might be impacted by an alternative of the Kensington Project (Hall, 1988; 1991b). The village is reported to be approximately 7 acres in size and located in an area now overgrown by large spruce and hemlock. The area reportedly contains culturally modified trees. While the place is an ideal setting for the placement of a permanent village, no midden material or distinctly recognizable house ruin depressions have been noted to date (Alaska Heritage Resource Survey, 1986; Sealaska Corporation, 1975). The village site is thought to be as old as 600 years and, thus, may be well masked by vegetation.

Historic Sites

Two sites associated with the early mining period have been placed on the Alaska Heritage Resource Survey. These are Comet Landing (49-JUN-033) and Kensington Mill (49-JUN-240). These were investigated in 1983 by the Forest Service. Subsequently, the Tongass National Forest, Forest Supervisor requested (Gee, 1983a; 1983b) and received a determination of "Not Eligible" for inclusion on the National Register of Historic Places for both sites from the State Historic Preservation Officer that same year (Dilliplane, 1983).

Specific project component examinations for the Kensington Venture were performed by Ream (1987) and Hall (1988; 1991b). Through proposed project and Forest Service examination, much historic material, mostly now in states of disrepair, has been recorded (Gee, 1983a; 1983b; Ream, 1987; Hall, 1988; 1991b).

VISUAL RESOURCES

The Forest Service recognizes the visual landscape as a basic resource to be treated as an essential part of and receive equal consideration with the other basic resources (Forest Service Manual 2280). The Visual Management System (VMS) of the Forest Service includes standards for visual resources on National Forest System lands. The VMS is an integral part of multiple use planning and decision making processes.

PROJECT AREA DESCRIPTION

The proposed mine is near three physiographic provinces: the Coast Mountains and lower Coastal Foothills along the east side of Lynn Canal; the Alsek (Chilkat) and Fairweather Range sections of the Pacific Border Ranges province on the westside of Lynn Canal, and the canal itself, part of the Chatham Trough section of the Coastal Trough province (Wahrhaftig, 1965).

Visually, the physiographic provinces appear as three general landscape components: the water; the lower, rounded forested foothills on the canal banks and islands; and the steep, often ice-clad taller peaks behind the foothills to the east and west of Lynn Canal. For visual management, the Forest Service has combined the landscape components and portions of physiographic sections into a landscape character type, the Coast Range Type. This type is characterized by the visual dominance of the water and tall mountain peaks (Dames & Moore, 1989b).

The general study area is divided into two distinct viewsheds by the ridge running north from Point St. Mary.

To the west is Lynn Canal viewshed. To the east is the Berners Bay viewshed.

Lynn Canal landscape is characterized on both sides of the water by unbroken shorelines backed by forested foothills and steep, rocky and snow capped peaks. In the project area, the shoreline is seen as a smooth line created

by the cobbled beach. There are no cliffs or large rock outcrops in the project area to interrupt the shoreline. On Lions Head Mountain, the tallest (5,400 feet) mountain near the project site, avalanche chutes, rock, and snow are the primary features seen from Lynn Canal.

Vegetation, primarily forest as seen from the Alaska Marine Highway, starts at the beach and covers the lower elevations and foothills with a uniform appearing forest. Patterns in the forest canopy are evident from the air. Muskeg openings are scattered throughout the forest in sloping and flat areas. Scattered deciduous trees and shrubs occur along riparian areas. The overall effect is one of subtle variation in pattern and color when viewed from water level, and of marked patchiness and variation when viewed from the air.

Human alterations to the landscape are not highly evident along Lynn Canal in the general project area. The forest appears intact when viewed from the water. At the project site a small waste rock pile is visible as a gray shape against the dark green forest cover. From some vantage points the temporary camp buildings near the beach can be glimpsed.

Lighting affects the topographic detail that can be seen in the project area. In dim light and fog, the darkness of the forest cover masks most topographic relief at the lower elevations. On a clear, bright day, the Sherman Creek drainage is visible as a notch in the forested foothills. The Sherman Creek drainage is nearly perpendicular to Lynn Canal and is visible from a wide viewing angle from the water. The Sweeny Creek drainage, also seen as a notch in the forested foothills, is screened in its lower reaches by a ridge that runs parallel to Lynn Canal. From Sherman Creek south to Point St. Mary, the narrow beach is backed by a uniform appearing, forested slope which ends in a ridgeline much lower than the tall peaks of the Kakuhan Range. The ridgeline drops in elevation to Point St. Mary. The Coast Mountains on the east side of Berners Bay can be seen in clear weather as a backdrop to the ridge of the peninsula ending at Point St. Mary.

Berners Bay is a primary recreation destination for Juneau area residents who most often are in small power boats or sea kayaks.

The Berners Bay viewshed is more confined by topography than Lynn Canal. The north-south oriented bay has a more convoluted shoreline than Lynn Canal. Several coves and the delta created by the outflow of the Antler, Berners, and Lace rivers at the north end of the bay give the shoreline some visual variety. From Echo Cove, where there is a public boat ramp, and from across the bay near Sawmill Creek, Slate Creek Cove is in the background visual range and no details of the landscape can be seen.

In Slate Creek Cove, the beach is narrow and the foothills rise quite abruptly from the water. The forest appears uniform to the top of the ridge which separates Lynn Canal and Berners Bay. The snow capped peaks of the Chilkat Range on the west side of Lynn Canal form a distant backdrop over the ridge of the peninsula behind Slate Cove when viewed from the east side of Berners Bay.

Critical viewpoints in both viewsheds were marked along common air and water travel routes, access points, and documented recreation use areas. Lynn Canal is a major transportation corridor for both boats and planes. Lynn Canal viewshed is traveled by tourists and residents on routes followed by the Alaska Marine Highway System Ferries, as well as private cruise ships. Views of the project area by boat passengers typically occur from a distance of 1 to 2 miles offshore. (*See Figure 3-30, Lynn Canal Viewshed*). Commuter airline routes between Juneau and Skagway and Haines also follow Lynn Canal and provide air passengers with brief overhead views of the project site.

THE VISUAL MANAGEMENT SYSTEM

The VMS is based on a set of premises relating to landscape character, viewer expectations, number of viewers, duration of views, distance zones, and resource management and perceptual variables. An in-depth discussion of the VMS process applied to the project area is provided in the Visual Resources Technical Report (Beck and Baird 1990). Management decisions relating to visual resources are keyed

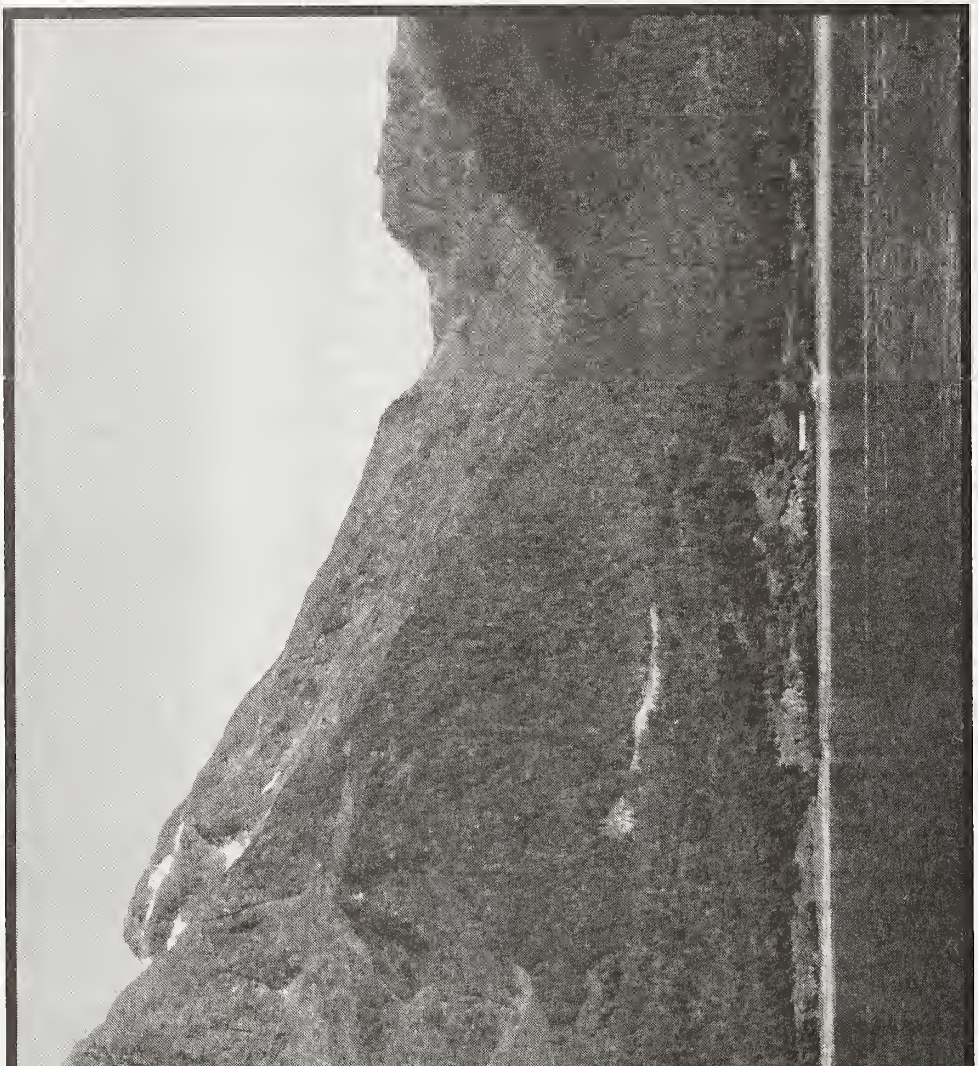


Figure 3-30, Lynn Canal Viewshed

to Visual Quality Objectives (VQO) developed for a particular area. The management VQOs have been mapped for the Tongass National Forest. (*See Figure 3-31, Visual Quality Objectives Map*).

The VQOs are visual resource management goals associated with the values determined for variety class and sensitivity level. Each describes a different degree of acceptable alteration of the natural landscape based upon the importance of esthetics (USDA Forest Service, 1977).

Character Type and Variety Class

The classification of visual resources by the VMS process is like a sorting process. The first sort is made on a gross scale to determine character type, which is largely based on physiographic province.

Within character types, the landscape is divided into three variety classes. Features such as landforms, water forms, rock formations, and vegetative patterns are compared with those commonly found in a character type. From this comparison, an area's overall degree of scenic quality and variety class ratings are determined. (*See Figure 3-31, Visual Quality Objectives Map*).

- Class A - Distinctive landscape is not common to the character type and features landform, vegetative patterns, water forms, and rock formations of unusual or outstanding visual quality.
- Class B - Common refers to areas where features tend to be common throughout the character type.
- Class C - Minimal includes areas exhibiting little change or variety in visual elements.

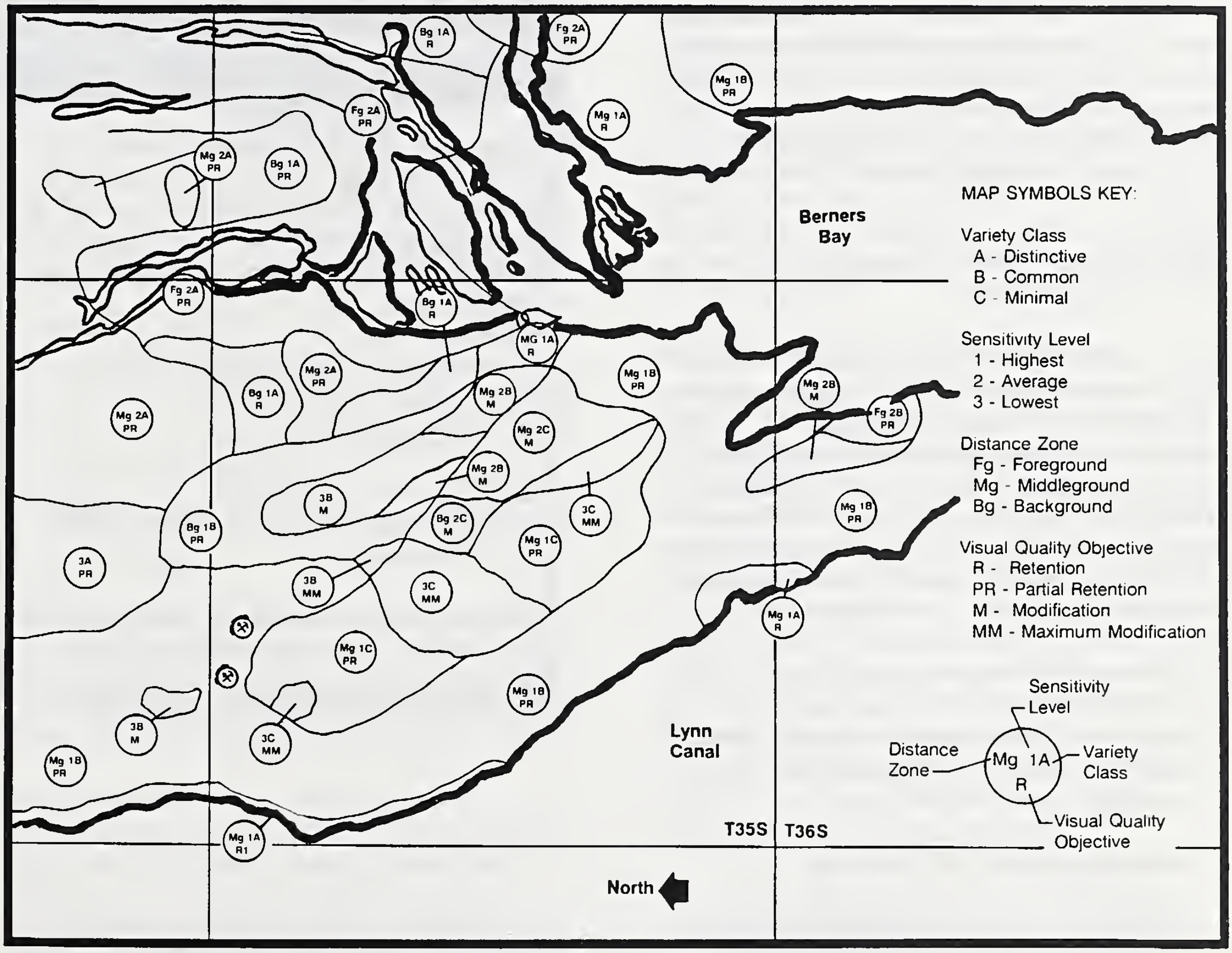


Figure 3-31, Visual Quality Objectives Map

Sensitivity Level

"Sensitivity Levels are a measure of people's concern for the scenic quality of the National Forests" (USDA Forest Service, 1977). Sensitivity levels are based on an assessment of forest travel routes, use areas, and water bodies as being either of primary or secondary importance, combined with the likely concern of users for the scenic qualities of the Forest. The three sensitivity levels are:

- Level 1, Highest Sensitivity
- Level 2, Average Sensitivity
- Level 3, Lowest Sensitivity

Distance Zones

Distance zones indicate the likely visual divisions of a particular landscape based on viewer position. The foreground zone is limited to distances at which details can be perceived. Usually this zone is less than 0.5 mile from the viewpoint. The middleground extends from the foreground to 3 to 5 miles from the viewer. The background zone extends from the middleground to as far as the eye can see. (*See Figure 3-31, Visual Quality Objectives Map*).

KENSINGTON STUDY AREA VISUAL QUALITY OBJECTIVES

Near the Kensington Project, Forest Service VQOs represent a mosaic of management goals ranging from Retention to Maximum Modification. (*See Figure 3-31, Visual Quality Objectives Map*). Preservation, which allows ecological changes only, is not a VQO in the study area. This objective applies to designated wilderness areas, other special classified areas, and some unique management units.

- **Retention (R)** calls for management activities which are not visually evident. Retention of elements of the characteristic landscape should be accomplished during operation or immediately after.

- **Partial Retention (PR)** allows for management activities that remain visually subordinate to the characteristic landscape. New form, line, color, or texture may be introduced as long as they remain visually subordinate.

- **Modification (M)** permits management activities that may visually dominate the characteristic landscape. Introduced elements should borrow from naturally occurring form, line, color, texture, and scale so they are compatible with the natural surroundings.

- **Maximum Modification (MM)** allows activities that may dominate the characteristic landscape. When viewed as background, the visual characteristics must be those of natural occurrences within the surrounding area. In the middleground and foreground, alterations may be out of scale and less compatible with natural landscape elements. Reduction of visual contrast should be accomplished within 5 years.

SOCIOECONOMIC ENVIRONMENT

The economic and fiscal impacts generated from the Kensington Gold Project would be most likely isolated to the City and Borough of Juneau; but, given the proximity of the towns of Haines and Skagway, these communities may be affected also.

The description of the socioeconomic environment focuses on the conditions in the following areas:

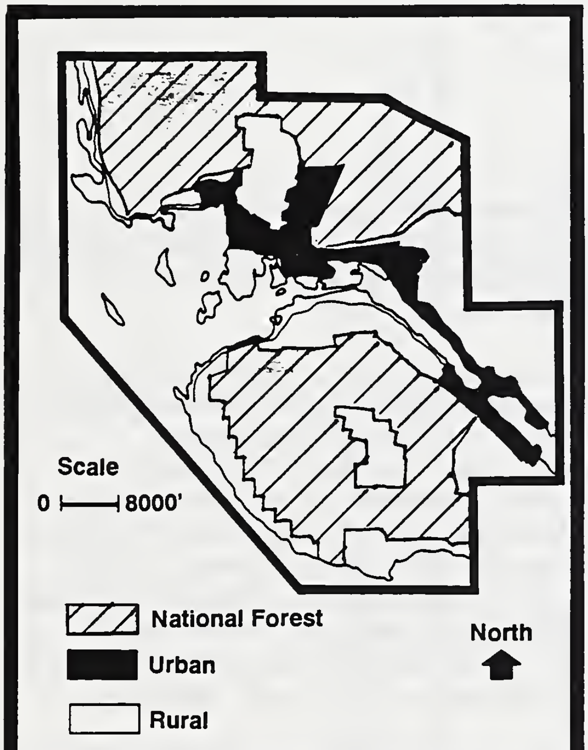
- City and Borough of Juneau
- City of Haines; Borough of Haines
- City of Skagway

These areas have been defined in terms of socioeconomic characteristics including the demographic trends, economic indicators, and capacity of present jurisdictional services.

CITY AND BOROUGH OF JUNEAU

People reside and/or work in the following communities and areas within the City and Borough of Juneau. (*See Figure 3-32, Map of the City of Juneau*).

- Juneau
- Douglas
- North Douglas
- Thane
- Salmon Creek
- Lemon Creek
- Mendenhall Valley
- Fritz Cove
- Auke Bay
- Lena Cove



Source: City and Borough of Juneau, Alaska Plan

Figure 3-32, Map of the City of Juneau

The discovery of gold in the early 1880s brought a major population influx to the Juneau area. Like many Alaska towns, Juneau and Douglas were developed as a result of gold mining activities. By the turn of the century, the area became a hub of gold mining activity and harbored some of the largest gold mining and milling operations in the world in their time: the Treadwell Complex, the Alaska-Gastineau Operation, and the Alaska-Juneau Complex.

Time, world wars, and labor costs closed the mines by 1944. With the closure of the mines, the local economy reflected growth due to seafood harvesting and processing and the establishment of Juneau as the seat of the Alaska Territorial Government. The area benefitted from increasing levels of government spending, particularly during the early 1930s and World War II. With Statehood in 1959 and the 1968 discovery of oil in Prudoe Bay, the overall economy of Juneau continued to expand as a result of increased government spending.

Population/Demography

In 1990, the U. S. Bureau of Census reported a preliminary estimate of the population of the City and Borough of Juneau at 26,696 people, up 37 percent over the 1980 census of 19,520 people. The 1990 Alaska revenue sharing program estimate for Juneau population was 28,881 people. The population of the Juneau area has increased every decade since the late 1890s. (*See Table 3-14, Population History - Juneau Area*). The population of the City and Borough of Juneau has increased at an average annual rate of increase of about 4 percent per year since 1970.

Approximately 5 percent of Alaska's total population lives in the City and Borough of Juneau. The U.S. Bureau of Census estimated the number of households in the City and Borough of Juneau in 1990 at 10,626. An average of 2.5 individuals reside per household.

In 1980, residents (25 years of age and older) in the City and Borough of Juneau exceeded the State norm in education with 91.1 percent of the people completing 12 years or more of school and 33.9 percent completing 16 years or more of school. In comparison, the State averages for this time period were 82.5 percent and 21.1 percent, respectively, for those completing 12 and 16 years or more of education.

Table 3-14, Population History - Juneau Area

Year	City and Borough of Juneau	City of Douglas	Auke Village	Town of Treadwell	Total Alaska
1890	1,253[2]	402	324	--	32,052
1900	1,864[2]	825	261	522	63,592
1910	1,644[2]	1,722	218	1,222	64,356
1920	3,058[2]	919	--	325	55,036
1930	4,043[2]	593	--	16	59,278
1940	5,729[2]	522	--	13	72,524
1950	5,956[2]	699	295	--	128,643
1960	6,797[2]	1,042	490	--	226,167
1970	6,050[2]	1,243	--	--	300,382
1980	19,528	--	--	--	401,851
1990	26,696[1]	--	--	--	551,947[1]

Sources: Census Alaska: Number of Inhabitants (1792-1970)
U.S. Department of Commerce, Bureau of Census, 1980 and 1990.
Alaska Department of Labor
[1]Finalized
[2]City of Juneau only

Employment

Total employment in the Juneau area has increased from 11,496 persons in 1981 to a peak of 14,122 persons in 1990. Overall employment was up six percent from 1989, with an additional 859 jobs. Over one third of the increase was in Federal government employment, which accounted for 320 additional jobs. The temporary workforce hired to conduct the census helped boost employment in Federal government which accounted for over one third of the additional jobs. The second largest growth area was in service industries, which reported an increase of 248 jobs over the 1989 level (*See Table 3-15, Juneau Area Non-Agricultural Employment, 1981-1990*).

Government employment is the backbone of the Juneau area economy. It provides for over 50 percent of local employment and more than 85 percent of the city's economic base (The McDowell Group, 1990c). (*See Figure 3-33, Percentage Comparison of Average Annual Juneau Area Employment, 1990*).

The impact of declining oil revenues was felt in the Juneau area economy in late 1986. State government employment in Juneau declined to just under 3,900 jobs in 1987, but has rebounded to reach a decade high of 4,533 jobs in 1990. (*See Figure 3-34, Government Employment in Juneau*).

Prior to 1986, government (primarily State government) was a constantly growing force in Juneau's economy. In 1969, before development of the North Slope petroleum reserves, government employment in Juneau totaled 3,600 jobs including about 1,900 State government jobs. Four years later, in 1973, government accounted for 4,638 jobs in Juneau including 2,830 State jobs. For the next 10 years, an average of 170 new State government jobs were generated in Juneau each year.

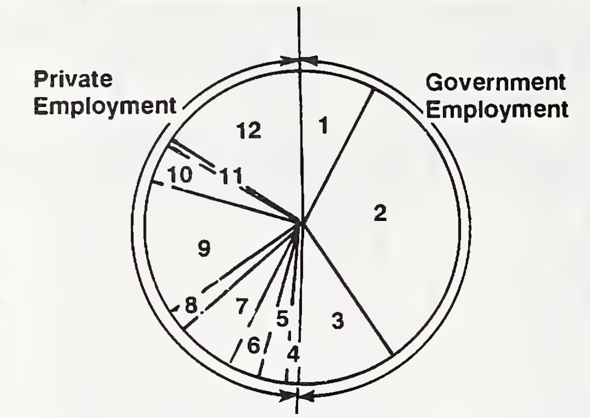
Employment in the Federal government in the Juneau economy has remained fairly constant for the past two decades. In 1970, there were an estimated 1,200 Federal government workers in Juneau. Until the recent increase in 1990, Federal government had varied only slightly.

Employment in local government increased through the early 1980's. By 1985, there were 1,368 local government employees in Juneau. Local government employment declined slightly in 1986 and 1987, with a loss of about 200 jobs. Since 1987, local government employment has

Table 3-15, Juneau Area Non-Agricultural Employment, 1981-1990

	1984	1982	1983	1984	1985	1989	1987	1984	1989	1990
Private Employment										
Mining	--[1]	12	26	27	--[1]	--[1]	--[1]	169	112	74
Construction	506	563	775	796	733	396	391	341	345	414
Manufacturing	111	151	152	180	253	196	261	341	319	148
Transportation Communication, Utilities	1,029	916	794	775	777	707	771	747	857	911
Wholesale Trade	167	170	199	184	178	144	173	197	211	197
Retail Trade	1,523	1,720	1,767	2,020	1,938	1,781	1,764	1,826	1,993	2,042
Finance, Insurance, Real Estate	517	506	533	565	607	637	565	561	535	496
Services	1,311	1,639	1,803	1,937	1,981	2,028	1,079	1,947	2,085	2,333
Agriculture, Forestry, Fisheries & Nonclassified	--[1]	65	106	128	--[1]	--[1]	--[1]	62	81	59
Subtotal - Private	5,210	5,742	6,155	6,612	6,568	5,995	6,116	6,191	6,538	6,676
Government Employment										
Federal	1,075	1,973	994	1,021	1,039	1,051	1,035	1,039	1,086	1,406
State	4,032	4,223	4,263	4,288	4,389	4,224	3,898	4,040	4,299	4,533
Local	1,038	1,075	1,148	1,277	1,368	1,326	1,184	1,251	1,349	1,507
Subtotal - Government	6,145	6,271	6,405	6,586	6,796	6,601	6,117	6,330	6,725	7,446
Total Employment	11,355	12,011	12,560	13,196	13,364	12,596	12,233	12,520	13,263	14,122

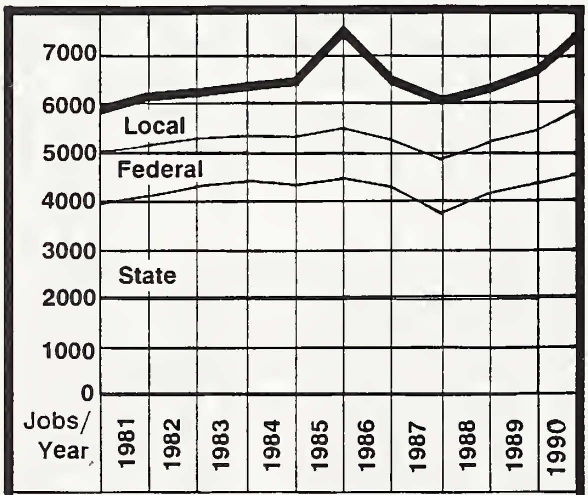
Source: Data from unpublished Alaska Department of Labor computer files
Note: Total may not add due to rounding.
[1]Not shown to avoid disclosure of data for individual firms.



1. Federal Government 10%
2. State Government 32%
3. Local Government 11%
4. Mining <1%
5. Construction 3%
6. Manufacturing 1%
7. Transportation, Communication, Utilities 6%
8. Wholesale Trade 1%
9. Retail Trade 15%
10. Finance, Insurance, Real Estate 4%
11. Forestry, Fisheries, Unclassified <1%
12. Services 17%

Source: Alaska Department of Labor, Research & Analysis Employment and Earnings Report

Figure 3-33, Percentage Comparison of Average Annual Juneau Area Employment, 1990



Source: Data from unpublished Alaska Department of Labor computer files

Figure 3-34, Government Employment in Juneau

again increased in Juneau. The retail wholesale trade business in the Juneau area along with the service industries account for about 32 percent of total employment. Jobs in transportation, communication, and public utilities accounted for about six percent of total employment. The mining, construction and manufacturing industries provided approximately five percent of the employment in 1990.

Income

Total annual income (wages and salaries) in the Juneau area for 1990 was over $403.6 million. Income for government employees was approximately $262.2 million as compared to $141.5 million for private sector employees. The highest total of wages and salaries in 1990 was paid to State government employees ($168.8 million) followed by the local government ($47.8 million), the Federal government ($45.5 million), and service employees ($39.2 million). The lowest total was for the combined agricultural, forestry, and fisheries sector and non-classified category ($1.3 million). (*See Table 3-16, Total Wages Paid in Juneau Area*).

The average wage for the Juneau area worker in 1990 was estimated at $28,582. Assuming 2.2 individuals per wage earner in the Juneau area, this can be translated to an average per capita income of approximately $12,992. A comparison of income (wages & salaries) for workers by industry is provided in *Table 3-17, Average Wage and Salary Income Per Worker in Juneau.*

Community and Public Services

Community and public services in the City and Borough of Juneau include the following.

- Education
- Law Enforcement
- Fire Protection
- Ambulance
- Hospital and Medical Services
- Mental Health/Drug and Alcohol Treatment
- Water Supply
- Wastewater Treatment
- Solid Waste
- Electric Utilities

Table 3-16, Total Wages Paid in Juneau Area ($x1,000)

Private Employment	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Mining	$ [1]	$ 444	$ 789	$ 951	$ [1]	$ [1]	$ [1]	$ 6,986	$ 5,185	$ 2,858
Construction	18,475	19,313	26,535	26,194	22,887	12,069	12,472	12,286	13,088	16,777
Manufacturing	2,319	3,443	3,923	4,366	7,225	5,924	7,732	10,544	10,313	3,037
Transportation Communication, Utilities	30,128	28,419	23,495	23,637	22,930	20,288	20,282	19,846	24,074	25,118
Wholesale Trade	4,507	4,943	6,066	5,330	4,901	3,482	4,829	5,332	7,448	6,325
Retail Trade	20,924	24,167	27,252	30,266	27,236	24,533	23,886	24,803	30,729	31,755
Finance, Insurance, Real Estate	11,381	13,254	14,701	15,604	16,207	17,817	16,074	15,297	16,194	15,163
Services	24,124	31,635	36,400	39,269	37,907	37,729	38,302	34,522	34,804	39,170
Agriculture, Forestry, Fisheries & Nonclassified	[1]	843	1,579	1,762	[1]	[1]	[1]	1,657	1,527	1,266
Subtotal - Private	$112,787	$126,461	$140,740	$147,380	$140,505	$123,819	$ 128,515	$131,273	$143,362	$141,469
Government Employment										
Federal	$ 28,063	$ 27,513	$ 29,195	$ 30,306	$ 32,654	$ 35,074	$ 36,131[2]	$ 37,247	$ 41,315	$ 45,500
State	118,785	134,525	142,835	144,838	154,338	151,427	146,790[2]	145,011	155,792	168,803
Local	25,450	28,581	$32,427	37,669	42,054	42,118	$39,902	40,074	44,016	47,863
Subtotal - Government	$172,298	$190,619	$204,457	$212,813	$229,046	$228,619	$222,823[2]	$222,332	$241,123	$262,166
Total Employment	$285,085	$317,078	$345,197	$360,193	$369,551	$352,438	$351,338[2]	$353,605	$384,485	$403,635

Source: Data from unpublished Alaska Department of Labor computer files
Note: Total may not add due to rounding.
[1]Not shown to avoid disclosure of data for individual firms.
[2]Alaska Department of Labor, 1987.

Table 3-17, Average Wage and Salary Income Per Worker in Juneau ($x1000)

Private Sector	1984	1982	1983	1984	1985	1986	1987	1986	1985	1990
Mining	$ [1]	$38.6	$30.9	$35.9	$ [1]	$ [1]	$ [1]	$41.4	$46.2	$38.6
Construction	36.5	34.3	34.3	32.9	31.2	30.5	31.9	36.1	37.9	40.5
Manufacturing	21.0	22.8	25.9	24.3	28.5	30.2	29.6	30.9	32.3	20.5
Transportation Communication, Utilities	29.3	31.0	29.6	30.5	29.5	28.7	26.3	26.6	28.1	27.6
Wholesale Trade	27.1	29.1	30.4	29.0	27.5	24.3	28.0	27.1	35.3	32.1
Retail Trade	13.7	14.0	15.4	15.1	14.1	13.8	13.5	13.6	15.4	15.6
Finance, Insurance, Real Estate	22.0	26.2	27.6	27.6	26.7	28.0	28.5	27.3	30.3	30.6
Services	18.4	19.3	20.2	20.3	18.6	18.6	18.4	17.7	16.7	16.8
Agriculture, Forestry, & Fisheries	[1]	12.9	14.8	13.7	[1]	[1]	[1]	26.6	18.9	21.5
Subtotal - Private	$21.7	$22.0	$22.9	$22.3	$21.4	$20.7	$21.0	$21.2	$21.9	$21.1
Government Employment										
Federal	$26.1	$28.3	$29.4	$29.7	$31.4	$33.4	$34.9[2]	$35.8	$38.0	$32.4
State	29.5	31.9	33.5	33.8	35.2	35.8	36.6[2]	35.9	36.2	37.2
Local	24.5	26.6	28.3	29.5	30.7	31.8	32.2[2]	32.0	32.9	31.7
Subtotal - Government	$28.3	$30.4	$31.9	$32.3	$33.7	$34.7	$35.4[2]	$35.1	$35.9	$35.2
Total Employment	$25.1	$26.4	$27.5	$27.3	$27.7	$28.0	$28.1[2]	$28.2	$29.0	$28.6

Source: Data from unpublished Alaska Department of Labor computer files
Note: Totals may not add due to rounding.
[1]Data not available.
[2]Alaska Department of Labor, 1987.

Education. Juneau area public schools include five elementary schools, two middle schools, and one high school. Six privately operated schools provide pre-school and kindergarten through eighth grade education. The University of Alaska Southeast is accredited to offer baccalaureate, professional, and master degree programs in business, fisheries, public administration, and education. The Juneau/Douglas Community College offers vocational and technical associate degree programs.

Breakdowns of enrollment in the Juneau-Douglas School District are provided in *Table 3-18, Public School Enrollment by School, Juneau-Douglas School District* and *Table 3-19, Public School Enrollment by Grade, Juneau-Douglas School District.* Student enrollment in private schools in the Juneau area is shown in *Table 3-20, Private School Enrollment.*

Public elementary and secondary education is a mandated function of all first class or home rule cities, unified cities and boroughs in Alaska. Each of these municipalities has an elected city council or assembly with responsibility for all local government functions and an elected school board to which some eduction functions are delegated by state statute.

The Juneau School Board is responsible for fiscal and operational management and oversight of the public school system in the Juneau area. One of the more important responsibilities of this board is to evaluate enrollment trends to insure that adequate space exists for current and projected student enrollment. Because some of the elementary schools are currently at or above capacity, temporary classroom modules are being used to expand classroom space.

Table 3-18, Public School Enrollment by School, Juneau-Douglas School District

School	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91
Elementary									
Harborview	494	376	321	315	301	536	542	583	613
Capital	311	337	309	305	296	0	0	0	0
Gastineau	304	328	292	308	287	298	326	365	394
Glacier Valley	664	447	410	424	432	442	538	594	587
Mendenhall River[1]	0	468	491	544	553	544	473	504	528
Auke Bay	639	530	459	504	470	486	481	499	540
Total Elementary	2,412	2,486	2,282	2,400	2,339	2,306	2,360	2,545	2,662
Junior High/Middle									
Marie Drake	435	494	478	467	452	454	433	439	468
Floyd Dryden	616	578	585	560	541	513	586	660	697
Alternate	13	15	5	0	0	0	0	0	0
Total Junior High/ Middle	1,064	1,087	1,068	1,027	993	967	1,019	1,099	1,165
High School									
Juneau-Douglas	839	848	1,212	1,175	1,133	1,143	1,181	1,211	1,286
Alternate	70	82	57	120	97	32	[2]	[2]	0
Total High School	909	930	1,269	1,295	1,230	1,175	1,181	1,211	1,286
Other[3]	28	33	31	16	18	18	22	0	0
Total Enrollment	4,413	4,536	4,650	4,738	4,580	4,466	4,582	4,855	5,113

Source: The McDowell Group (1990a)
Note: Number in tables have been averaged using First and Final Attendance Reports.
[1]Opened 1983-84 school year.
[2]Alternative HS included in HS count.
[3]Other includes St. Jude, Project Independence, and correspondence study.

Table 3-19, Public School Enrollment by Grade, Juneau-Douglas School District

Grade Level	1982-83	1983-84	1984-84	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91
Pre Elementary	--	--	--	--	40	18	27	17	0
Kindergarten	357	334	372	430	373	373	351	440	464
First	388	444	458	461	427	441	446	410	491
Second	342	343	392	397	377	429	405	433	425
Third	329	343	366	391	391	343	398	403	435
Fourth	318	334	357	374	376	362	396	447	415
Fifth	330	329	348	364	373	358	359	360	426
Sixth	349	348	347	351	343	341	355	363	396
Seventh	375	359	354	339	329	315	348	373	378
Eighth	359	380	368	338	321	311	316	352	379
Ninth	335	353	362	373	329	325	387	344	407
Tenth	300	330	344	307	312	284	282	343	335
Eleventh	288	273	285	282	254	284	268	265	309
Twelfth	266	258	239	214	240	251	248	260	234
Alternate H.S.	70	82	57	120	97	32	--[1]	--[1]	--[1]
Project Independence	8	7	3	0	0	0	0	47	18
Total Enrollment	4,414	4,517	4,652	4,741	4,582	4,467	4,586	4,857	5,113

Source: The McDowell Group (1990e)

Note: Numbers in the table have been averaged using First and Final Attendance Reports.

[1]Alternative H.S. Included in H. S. count.

Table 3-20, Private School Enrollment

	1987-88	1988-89	1990-91
Pre-elementary	103	229	217
K-12	221	180	175
Total Enrollment	324	409	392

Recently, the Juneau School Board proposed and studied two options to ease potential for school overcrowding. These options were as follows.

- Construction of a new elementary school to the north of downtown Juneau coupled with the renovation and reopening of the Capital School to serve approximately 650 students.
- Construction of a new middle school north of downtown with flexibility for future use and a capacity to serve approximately 650 students.

In the October 1989 municipal elections, Juneau voters approved a school bond issue to purchase land and construct a new middle school.

The State of Alaska supports a large percentage of both school operational costs and capital construction costs. Juneau's operating costs are funded at about 65 percent State funds and 35 percent local funds. Most of the State support for school operations comes from a foundation fund that is based on a formula which requires a minimum local contribution of 4 mils. Juneau currently devotes 8.8 mils on a total estimated assessed property value of $1.17 billion (for the 1989-90 school year).

Based on the State's foundation funding formula, increased enrollment results in more State money. If increased enrollment is accompanied by increasing local property valuation as would occur with the Kensington Project, then the required local contribution would increase accordingly at the 4 mil rate. According to the formula, each additional 17 elementary students or 13 secondary students bring in one additional state funding unit at $60,000 per unit, less the local 4 mil contributions.

Law Enforcement. The City and Borough of Juneau is served by two law enforcement agencies, the Juneau Police Department and the Alaska State Troopers. The 36- officer Juneau Police Department has responsibility for the Juneau-Douglas area and portions of the Mendenhall Valley. The State Troopers police the remainder of the Borough. Although there are no formal agreements between the Juneau Police Department and the Alaska State Troopers, both groups work together and coordinate activities to mutual benefit.

Fire Protection. There are five district fire stations in the City and Borough of Juneau. Lynn Canal and Douglas stations are an all volunteer status while the Juneau, Glacier, and Auke Bay stations have both paid and volunteer firefighters. Special services provided by the Fire Districts include emergency medical services, dive rescue for water related emergencies, crash-fire-rescue service at the Juneau International Airport, and a fire safety education program. In 1988, there were 35 paid firefighters in the area and 150 volunteer firefighters.

Ambulance. Ambulance services in the City and Borough of Juneau are provided by certified emergency medical technicians employed by the Fire Department. There are presently two full-time service radio equipped ambulances in the Juneau Fire Department to provide emergency medical aid. There is one back-up ambulance. All full-time firefighters in the Juneau Fire Department are certified Emergency Medical Technicians. Twenty- three of the full-time firefighters have received Advanced Life Support training.

Hospital and Medical Services. Juneau's health care sector includes the following facilities.

- Bartlett Memorial Hospital
- Southeast Alaska Regional Health Corporation
- St. Ann's Nursing Home
- State of Alaska's Pioneers Home

Bartlett Memorial Hospital is operated by the City and Borough of Juneau. This facility is a 64-bed medical center offering a wide range of health care services including in-patient, out-patient, and newborn services. Bartlett Memorial Hospital handled 14,268 emergency room visits in 1990, admitted over 2,500 patients, and performed 1,620 operations. The hospital recently underwent major emergency room expansion and now has substantial excess emergency room capability.

The hospital occupancy rate for 1990 was 46.4 percent for adults/children and 37.5 percent for the newborn section. The 1981-90 average occupancy rate for the hospital is 48.1 percent for adults/children and 43.1 percent for the newborn section. Only in 1983 and 1984 did the occupancy rates for adults/children and newborns both exceed 50 percent.

The Southeast Alaska Regional Health Corporation provides medical and dental services to Natives, American Indians, and all active and retired Coast Guard personnel. Doctors and dentists practicing in this non-profit health care facility are commissioned officers of the U. S. Public Health Service.

Long term medical care for the elderly is provided by St. Ann's Nursing Home, which has a 45-bed capacity. The recently opened State of Alaska Pioneers Home also provides limited nursing care.

In 1988, there were 40 physicians licensed in the Juneau area including family practitioners, surgeons, orthopedics, pediatricians, dermatologists, and psychiatrists. Fifteen dentists were licensed in Juneau that year along with two orthodontists. Eight chiropractors, three optometrists and one naturopath also served the Juneau area in 1988.

Mental Health/Drug and Alcohol Treatment. Drug and alcohol dependency treatment programs are operated by the City and Borough of Juneau, the U. S. Indian Health Service (through contract with the Southeast Alaska Regional Health Corporation) and a private concern, Lakeside Recovery Corporation.

The City and Borough of Juneau operates both in-patient and out-patient chemical dependency programs. This facility houses both a 15-bed in-patient hospital and an out-patient treatment program through its drug and alcohol treatment unit. The CBJ Chemical Dependency Division operates on an annual budget of approximately a $1.8 million. Sources of revenue include user fees and State grants. The 4-week in-patient program currently has a 90 day waiting list for admission. The City and Borough of Juneau recently requested $920,000 in State funds to increase the capacity of the 15 bed Juneau Recovery Unit. The proposed expansion would provide adequate capability to serve a population of up to 35,000 people. The out-patient drug and alcohol treatment program is operating over capacity with approximately 170 clients and only three counselors. During 1988, the Mental Health Clinic provided services to approximately 600 clients in Juneau, or about 45 out of every 1000 local residents. Although the clinic had a waiting list in 1988, there were also three and sometimes four vacant positions on the clinic staff. Filling those positions could have more than satisfied the additional demand.

Water Supply. Public water supplies for the City and Borough of Juneau are obtained from the Salmon Creek Reservoir and a well field in the lower Gold Creek Watershed in a mountain valley, known as Last Chance Basin, east of downtown Juneau.

The Gold Creek well field currently consists of three wells operating in conjunction with an infiltration gallery. Improvements currently underway will add two new wells and eliminate the infiltration gallery. The new live well facility should be in full operation by the end of 1990. This well field provides water to the City and Borough of Juneau area-wide system either directly via the Jualapa Tunnel transmission main or via the Mill Tunnel storage reservoir. The Mill Tunnel reservoir is a converted mine railway tunnel, with a 3.4 million gallon storage capacity that is used to provide 6,500 gallons per minute (gpm) surge flow capacity to downtown Juneau. It also serves as a potable water storage reservoir.

The current configuration of the Juneau's area-wide water system makes public water available to about 80 to 85 percent of Juneau's population. Actual connection rates are less than 100 percent, however, since connection to

the system is not mandatory and many residents have chosen to continue using private systems.

For much of the year, the Salmon Creek reservoir provides water to the valley service area while the well field in Last Chance Basin provides water only to the Juneau and Douglas Island service areas. Each spring, however, the Salmon Creek reservoir becomes turbid and is unusable for a period of 5 to 10 weeks. During this period, the Last Chance Basin well field is the only water supply for the Juneau area-wide water system.

Because the well field system must be capable of meeting the Juneau area's average expected future demand (especially during periods when the Salmon Creek supply is unusable), improvements are being made. When completed, the well field should provide up to 6,000 gpm or 8.64 million gallons per day sustained flow. As of February, 1990, the system was currently at about 4.1 million gallons per day, with a maximum demand of 8.8 million gallons per day.

Wastewater Treatment. There are three treatment plants serving the City and Borough of Juneau. They are as follows.

- Auke Bay Treatment Plant
- Mendenhall Valley Treatment Plant
- Juneau-Douglas Waste Water Treatment Plant

The Auke Bay Treatment Plant is located approximately 12.5 miles north of Juneau on the Glacier Highway and serves the developed area around the head of Auke Bay. This facility has a capability of approximately 100,000 gallons per day. The plant flow is currently averaging about 80,000 gallons per day.

The Mendenhall Valley Treatment Plant is located on the south side of the Mendenhall River just north of the Juneau Airport property. This newly expanded plant is rated at 13.1 million gallons per day and serves an area extending from the hospital out to Auke Lake, including the entire airport area and the majority of the Mendenhall Valley. It is currently handling flows that average about 2 million gallons per day.

The Juneau-Douglas Wastewater Treatment Plant is located south of downtown Juneau on the northern rock dump adjacent to Thane Road. The area served extends from the treatment plant to the north end of the Aurora Basin boat harbor on the east side of the Gastineau Channel and south from the bridge on the west island side of the Gastineau Channel. The Juneau-Douglas Plant has a peak daily flow design of approximately 7.23 million gallons per day. Although the plant has excess capacity for average daily flow, it is presently overloaded on peak days. The excessive peak day loading is caused by the combined storm water/wastewater system in the downtown Juneau area. Rainy weather and extremely high tides dramatically increase the hydraulic loading of the plant, and at the same time greatly dilute the influent. The McDowell Group (1990c) reports that the Public Works Department has plans to separate the storm drain collection system from the wastewater collection system. This improvement would considerably extend the usable capability of the Juneau-Douglas plant.

The area-wide wastewater treatment plant systems serve about 75 percent to 85 percent of the area population. Residents living in the outlying areas not served by one of the three plants use individual waste water systems.

Solid Waste. Solid waste is collected by Channel Sanitation, a private local company that provides area-wide waste collection for local households and businesses. Solid waste is hauled to an incinerator/landfill facility in the Lemon Creek area. The facility is owned and operated by Channel Landfill, Inc. Burnable waste is separated from non-burnable items and incinerated in the twin incinerator facility. Non-burnable inerts are landfilled onsite. The incinerator facility currently handles about 70 tons per day and is virtually at capacity. During the summer months the amount of waste collected exceeds the burning capacity and the excess is landfilled.

Although a number of option have been considered for funding the installation of a third incinerator at the Lemon Creek facility an acceptable method has yet to be determined. Alternative means of disposing of non-burnable wastes are also being considered. Potential

methods include joint private/public funding for installation of a shredder to allow incineration of oversized inerts and shipment of materials out of state.

E & L Auto, a local scrap metal dealer and junk yard, accepts junk vehicles, miscellaneous scrap metal, and old batteries at their facility. Vehicles and scrap metals are compressed and shipped out of state in containers as demand requires. Scrap batteries are also shipped out of state separately.

Union Oil and Delta Western Chevron both backhaul the majority of the waste oil produced by their service stations to Seattle. Other local producers of waste oil include local, State, and Federal agencies; repair shops; and boat harbors. Chatham Materials and Service (CMS) is the only EPA licensed waste oil handler providing service in Juneau. CMS anticipates handling up to 100,000 gallons next year (E. Polley, 1991). The company sells waste oil to Red Samm Construction for burning in their asphalt plant. Oil not burned locally is transported to the lower 48 states for disposal or recycling by permitted facilities.

The State of Alaska provides a hazardous waste household collection service for local residents on an annual basis. Hazardous materials are collected and shipped to an approved disposal site in full compliance with the Resource Conservation and Recovery Act (RCRA).

Electric Utilities. Electric power requirements of the Juneau area are currently supplied by the Alaska Electric Light and Power Company (AEL&P). AEL&P serves residential, commercial, and government electric consumers in the Juneau area. *(See Table 3-21, Electrical Consumption in Juneau)*. Total electric power demand in 1990 was approximately 258 million kilowatt hours.

AEL&P relies on hydroelectricity to meet base demand and uses diesel generating facilities as a backup. AEL&P currently generates between 62 and 67 million kilowatt hours annually from its own hydroelectric facilities at Salmon Creek. The AEL&P hydroelectric facilities at Gold Creek and Annex Creek also supply minor amounts of energy. AEL&P receives an additional 195 million kilowatt hours annually from the Federally owned hydroelectric facility at Point Snettisham.

The Federally operated Alaska Power Administration has just completed the Crater Lake addition to the Snettisham project. Crater Lake could provide additional hydroelectric capacity of about 110 million kilowatt hours to AEL&P annually bringing the total installed capacity up to approximately 351 million kilowatt hours, an excess of 93 million kilowatt hours over 1990 demand.

Housing

According to an October, 1990 survey by the City and Borough of Juneau, there were an estimated 10,493 dwelling units in the Juneau area. Single family dwelling units comprised 70 percent of the units, 21 percent were multi-family units, and 9 percent were mobile homes.

Housing authorizations have dropped from a peak of 920 in 1983 to 58 in 1990. The 1990 total was about 6 percent of the peak construction period in 1983. Only two multi-family permits were requested from 1987-1990. During 1990, only 32 single-family housing units were authorized, compared to a peak of 272 in 1984. *(See Table 3-22, New Housing Units Authorized by Building Permits in Juneau)*.

For planning purposes in the unified transportation plan, the City and Borough of Juneau made the following assumptions for the next 20 years.

1. No new mobile home parks.

2. New code requirements calling for more land for zero lot line and duplex structures which will cause a 50 percent reduction in the past ratio.

3. Land will be increasingly scarce so condominium and multi-family development will be continued and will replace most of the market that would have been filled by mobile homes, duplexes, and zero lot line structures.

Based on the assumptions by the City and Borough of Juneau, the next 1,000 new dwelling units in the City and Borough of Juneau would

Table 3-21, Electrical Consumption in Juneau

	1981	1982	198[illegible]	198[illegible]	1985	1986	1987	1988	198[illegible]	1990
RESIDENTIAL No. of Customers KWH Used (x1,000)	7,939 72,330	8,494 94,329	8,912 106,209	9,722 113,202	10,181 127,158	10,241 118,710	10,209 110,824	10,319 116,755	10,451 122,484	10,666 127,231
COMMERCIAL No. of Customers KWH Used (x1,000)	1,103 40,538	1,166 48,913	1,214 56,049	1,340 61,864	1,314 66,070	1,251 65,710	1,226 67,931	1,237 55,581	1,244 72,949	1,250 75,291
GOVERNMENTAL No. of Customers KWH Used (x1,000)	379 35,361	402 39,879	434 46,214	467 47,729	513 50,267	348 49,196	341 48,541	344 50,359	334 53,115	340 55,998
TOTAL KWH Used (x1,000)	148,229	183,121	208,472	222,795	243,495	233,616	227,296	222,695	248,548	258,520

Source: The McDowell Group (1990e)

Table 3-22, New Housing Units Authorized by Building Permits in Juneau

Type of Dwelling	1981	1982	1983	1984	1986	1986	1987	1984	1989	1990
Single Family	264	128	175	272	137	51	10	7	30	32
Multi-Family Units	120	197	338	102	58	6	0	0	0	2
More Units	76	196	339	148	27	0	0	0	0	2
Mobile Homes	41	29	57	6	21	16	13	2	10	22
Additions or Conversions	0	3	11	1	0	1	3	--[1]	--[1]	--[1]
Total Housing Units	501	553	920	529	243	74	26	9	40	58

Source: The McDowell Group (1990e)

[1]Data no longer available.

be 45 percent single family, 31 percent multi-family structures, 5 percent duplexes, 2 percent zero lot line structures, and 2 percent mobile homes.

The Juneau Wetlands Management Plan (City and Borough of Juneau, 1989) indicates 3,220 developable acres from the central sewage plant in Indian Cove and from St. Annes to Bay View of which 1,946 acres is zoned for residential use.

An October 1990 City and Bureau of Juneau survey indicates a vacancy rate of 1.5 percent for all housing units, and a review of real estate listings indicates a diminishing supply of single-family dwellings. The Juneau Multiple Listing Service reported 166 listings in February 1986, 141 listings in February 1987, and 93 listings in February 1988. Only 54 single-family units were listed in July 1990.

The average sales price of condominiums increased between 1985 and 1986. This increase was due entirely to a number of new, premium units that were completed during 1986. During 1987 and 1988, a significant number of foreclosed condo units entered the market at very low prices; sometimes at half the 1985 sale price.

Residential housing prices increased by approximately 2 percent per month during the first half of 1989 or almost 10 percent overall from 1988. In 1989, the average single family home price was $106,201 (1,620 square foot home), $46,985 for a condominium (911 square feet), and $68,918 for a zero lot line dwelling (1,309 square feet).

Average 1990 sales prices (through October) increased to $116,700 for detached single-family homes, $78,350 for condominiums, $72,200 for zero lot line units, $45,820 per multi-family units, and $21,100 for mobile homes (Horan, 1990).

Fiscal Condition

Expenditures by category for the City and Borough of Juneau for fiscal years 1983 through 1990 are shown on *Table 3-23, City and Borough of Juneau Expenditures*. Expenditures rose from $94.3 million in fiscal year (FY) 1983 to a high of $130.5 in FY 1986. During FY 1990, expenditures were $113.1 million.

Revenue sources for the City and Borough of Juneau for the period of fiscal years 1983 through 1990 are shown on *Table 3-24, City and Borough of Juneau Revenues*. Total City and Borough of Juneau revenues and other financial sources were $108.2 million in FY 1983 to a high of $133.5 million in FY 1986. In FY 1990, revenues were $116.8 million.

State sources comprise the largest single source of revenue for the City and Borough of Juneau, approximately 30 percent of the total general fund revenues.

From FY 1983 through FY 1990 tax revenue increased from $13.3 million to over $29.1 million. As a result, tax dollars now represent 25 percent of total City and Borough of Juneau revenues.

Education expenditures were the single largest expense in the City and Borough of Juneau accounting for approximately 28 percent of the expenditures in FY 1990. The next highest expenditure was for public safety which accounted for approximately 6 percent of the total budget. All remaining expenditures amount to less than 10 percent each by function. Construction expenditures in FY 1990 amounted to over $5.7 million while debt service was approximately $8.6 million.

Recreation

The Juneau population can be characterized as relatively young and with a great demand for outdoor recreational opportunities. There are high participation rates for both organized and non-organized recreation activities. Numerous recreational opportunities exist for both summer and winter. Activities such as hiking, hunting, fishing, snowmobiling, boating, bicycling, camping, skiing, softball, and cross country skiing are available within the City and the surrounding area. (*See Table 3-25, Participation in Selected Leisure Time Activities in Juneau*).

Boating is a popular recreation activity for residents of the Juneau area. In 1988, there were a total of 1,344 permanent and transient slips in local small boat harbors, with additional

Table 3-23, City and Borough of Juneau Expenditures ($x1,000)

Category Expenditures:	FY 1983	FY 1984	FY 1985	FY 1986	FY 1987	FY 1988	FY 1989	FY 1990
Legislative	$ 1,311.4	$ 512.8	$ 1,036.7	$ 740.6	$ 792.5	$ 888.3	$ 808.6	$ 695.7
Legal	280.9	332.0	403.1	390.4	434.7	444.5	447.6	462.4
Administrative	598.9	772.1	796.5	1,796.9	1,404.2	1,426.4	1,266.8	1,581.1
Education	19,853.6	22,802.0	26,440.2	28,295.8	25,377.3	26,069.5	28,605.0	32,069.8
Finance	1,927.0	1,362.6	1,501.4	2,540.5	2,086.2	2,016.8	2,012.3	2,180.8
Libraries	599.1	707.6	874.6	1,120.2	987.4	936.0	893.4	904.7
Social Services	$ 2,492.5	$ 2,487.8	$ 3,057.5	$ 2,707.8	$ 2,661.9	$ 3,076.7	$ 3,726.0	$ 4,184.9
Recreation	1,093.4	1,383.6	1,650.3	2,797.0	2,487.9	2,291.6	2,460.0	$ 2,770.5
Planning & Lands	809.1	1,102.3	1,547.3	1,527.8	928.1	892.2	1,601.4	900.8
Management	1,036.6	315.0	123.6	44.0	97.0	256.7	5.5	54.5
Low Income Housing	4,406.8	4,729.6	5,369.2	6,487.3	6,862.8	6,386.1	6,538.1	6,813.6
Public Safety	4,167.2	3,637.4	5,603.0	4,530.6	4,129.1	3,479.6	3,826.3	3,996.0
Public Works	1,170.3	1,383.8	1,733.2	1,795.4	1,747.3	1,544.5	1,524.0	1,483.0
Public Transportation	259.1	356.5	434.6	976.7	794.4	734.3	736.1	819.2
Community Projects	191.4	601.6	709.8	796.3	715.9	663.1	664.8	836.7
Tourism & Conventions	31,957.9	23,489.8	21,581.4	10,989.8	9,674.4	3,997.5	6,234.0	5,717.7
Constructive Work in	3,591.5	7,685.8	8,121.2	7,160.7	7,981.2	8,258.1	8,096.5	8,573.1
Progress	351.9	821.6	1,840.2	2,080.2	1,728.0	1,333.0	1,082.1	1,178.8
Debt Service								
Other								
Total Expenditures	$76,098.6	$ 74,483.9	$ 82,823.8	$ 76,778.0	$ 70,890.3	$64,694.8	$ 70,528.5	$ 75,223.3
Other Financing Uses: Payment to Refunded Bond Escrow				$ 20,177.0				
Operating Transfers to Other Funds	$18,234.6	$ 33,701.1	$ 38,257.6	$ 33,591.5	$ 32,317.8	$30,021.6	$ 31,049.6	$ 37,830.9
Total	$94,333.2	$108,185.0	$121,081.4	$130,546.5	$103,208.1	$94,716.5	$101,578.1	$113,054.2

Source: The McDowell Group (1990e)

Table 3-24, City and Borough of Juneau Revenues ($x1,000)

Source	FY 1983	FY 1984	FY 1985	FY 198[illegible]	FY 1987	FY 1988	FY 1989	FY 1990
Revenues:								
Taxes	$ 13,291.2	$ 20,711.7	$ 24,349.3	$ 25,882.0	$25,546.5	$24,917.4	$ 26,521.1	$ 29,113.2
State Sources	38,231.4	44,456.7	47,185.6	42,043.1	35,321.4	33,884.0	35,462.3	35,580.2
Federal Sources	3,864.1	4,006.4	4,816.0	2,980.7	2,569.1	1,930.0	1,905.7	2,232.5
Charges for Services	563.7	884.1	1,383.1	1,322.9	1,357.8	1,372.3	1,306.2	1,238.4
Contract Services to Other Funds	524.4	360.7	422.5	487.8	543.8	503.9	494.4	484.6
Permits and Fees	863.0	1,032.1	1,032.4	753.6	804.3	702.3	758.6	1,195.7
Fines and Forfeitures	158.5	166.6	193.4	209.6	209.9	205.2	256.1	204,4
Interest Income	3,396.3	3,940.4	4,946.2	5,092.5	4,012.8	3,188.1	3,739.6	3,858.7
Land Sales	128.7	34.0	169.4	33.2	82.1	66.4	58.1	181.2
Rental Income	418.1	536.8	550.8	694.8	744.6	657.3	322.7	256.4
Contributions	8.5	2.5	12.2	0.8	0.2	10.0	--	--
Other	373.7	1,614.8	1,303.0	577.2	686.9	859.6	2,694.6	1,078.4
Total Revenues	$ 61,821.6	$ 77,746.8	$ 86,363.9	$ 80,078.2	$71,879.4	$68,296.6	$ 73,519.4	$ 75,423.8
Other Financial Sources:								
Proceeds from general long-term	$ 29,800.6	$ -	$ -	$ 19,255.0			$ 1,422.9	$ 8,500.0
obligations	16,618.4	-	-	34,181.3	$27,189.6	$25,505.9	27,663.6	32,195.9
Operating transfers from other funds		26,658.9	32,429.7	26.4	25.5	27.3	29.3	695.5
Other								
Total Other Financial Sources	$ 46,419.0	$ 26,658.9	$ 32,429.7	$ 53,426.7	$27,215.1	$25,533.2	$ 29,115.8	$ 41,391
Total Revenues and Other Financial Sources	$108,240.6	$104,405.7	$118,793.6	$133,540.9	$99,094.5	$93,829.8	$102,635.2	$116,815.2

Source: The McDowell Group (1990e)

Table 3-25, Participation in Selected Leisure Time Activities in Juneau

Activity	FY 1981	FY 1982	FY 1983	FY 1984	FY 1985	FY 1985	FY 1987	FY 1988	FY 1989	FY 1990
Adult Basketball	720	981[1]	637	644	728	743	602	400	N.A.	440
Adult Soccer	250	588	347	357	355	410	346	265	270	283
Adult Softball	1,900	2,040	2,070	2,222	2,075	1,870	1,400	1,438	1,500	1,559
Adult Volleyball	445	480	572	533	852	900	577	740	N.A.	980
Ski to Sea Relay	170	405	485	520	565	560	550	600	530	690
All CBJ Recreation Programs	7,339	9,236	9,143	9,294	11,643	11,314	17,568	11,800	N.A.[2]	N.A.[2]
Eaglecrest (Skier Days)	14,800	39,400	38,800	25,900	39,900	32,808	32,605	30,244	46,282	34,148
Augustus Brown Pool	93,839	99,717	98,280	117,000	144,555	131,372	129,750	118,000	105,000[3]	100,056
Library Circulation (check outs)	103,139	118,310	142,286	158,681	199,123	225,579	230,414	233,707	241,556	274,002
Salmon Derby Validations	7,524	9,067	10,775	12,762	12,423	4,360[4]	3,189	4,047	3,967	3,485
Centennial Hall Use										
Local Non-Profit				363	386	543	184	160	116	224
Local Regular				620	365	412	366	329	260	329
State				80	152	93	145	148	108	181
National/International				33	67	42	70	47	27	25
Calendar Year										
State Museum Visits	103,393	112,585	122,416	114,457	125,763	104,015	100,000	60,897	57,000	60,769
City Museum Visits (Opened 5/25/86)						6,699	26,000	22,552	12,567[5]	16,452

[1]In FY 1982, Juneau Parks & Recreation held an "over-30 basketball" program, and an "Indoor Soccer" program, which may account for the increased participation in those categories during that year.
[2]All City and Borough of Juneau Recreation Programs Total not available due to new tabulating procedures.
[3]Closed for remodeling.
[4]Only 3 Day tickets sold.
[5]Closed 1/1/89 to 5/30/89 for remodeling.

transient stalls. There were current waiting lists for slips at each of the three local harbors. Waiting times are 6 months for a 24 foot slip, 1.5 to 3 years for a 32 foot slip, and 5 years for a 42 foot slip. These waiting periods are typical for many small boat harbors in Alaska.

Hiking is an important recreational activity for Juneau residents. Juneau has an extensive trail network; perhaps the most extensive hiking system in Southeast Alaska. The Juneau Coastal Management program (1986) lists 101 miles of trail based on 1982 data while the Juneau Trails Recreation Opportunity Guide (USDA Forest Service, undated) lists over 120 miles of trail available for hiking.

The City and Borough of Juneau operates 13 ball fields and the Augustus Brown Swimming Pool. In addition to these facilities and publicly owned parks and trails within the City and Borough of Juneau, there are various private recreational opportunities available on a fee basis. These include numerous private facilities with aerobic activities; weight rooms; and indoor tennis, racquetball, and handball courts. There are also playgrounds at the elementary schools located around the City and Borough of Juneau.

Many local residents partake in hunting. Deer, moose, mountain goat, black bear, and brown bear are harvested by Juneau hunters.

The use of the Tongass National Forest is a major economic consideration in the City and Borough of Juneau. The National Forest serves as a primary recreation attraction to tourists and residents alike. The Tongass National Forest provides a variety of recreational opportunities including hunting, fishing, snowmobiling, hiking, biking, camping, touring, sight seeing, downhill and cross country skiing, and other activities throughout the year.

Transportation

The City and Borough of Juneau is serviced from the outside by both air and water. The Juneau International Airport and adjacent float plane lake provide support facilities for daily passenger and cargo jet services as well as for several air taxi operators. There are commercial passenger jet departures daily to Seattle, Anchorage, Fairbanks, and the larger Southeast Alaska cities. There is one Seattle air cargo flight daily, along with service provided by several national air freight and package delivery firms.

Recent terminal, parking, air freight, and runway improvements provide the community with good service. In 1988, approximately 160 tons of air freight were handled by the major airlines. Outgoing airport volume on major carriers totalled 163,000 passengers in 1987 and 180,000 passengers in 1988.

Waterfront facilities in Juneau include a two-berth deep draft dock front, ferry terminal landing, large unloading facilities, and four small boat harbors with 900 slips for vessels up to 85 feet in length. There are currently 40 acres of Juneau port facilities with 3,000 lineal feet of dock face and 4,400 potential lineal feet of dock face.

Two major barge lines provide the City with weekly Seattle freight service which includes temperature controlled and dry vans, roll on/roll off bulk cargo, and vehicle transport service. General freight consists of automobiles, construction materials, household grocery goods, and packaged hazardous materials. During 1987, a total of about 290 freight and dry bulk barges, or about five to six barges a week, served Juneau and outlying areas. Two scheduled barges arrive in Juneau each week. Each barge delivers 35 to 50 tons of goods for an annual total of between 3,500 and 5,000 tons. In addition to barge traffic, fuel tankers arrive twice weekly.

The Alaska Marine Highway System provides passenger and vehicles service as well as roll on/roll off service for shipping companies. Weekly service from Seattle and Prince Rupert, B.C. is available. The Juneau ferry terminal is at Auke Bay, approximately 14 miles north of Juneau.

Cruise lines made 287 port calls at the downtown Juneau waterfront with 225,400 passengers in 1990. Projections for 1991 are 319 port calls with 240,000 passengers (Lendaro, 1991).

CITY OF HAINES; BOROUGH OF HAINES

The City of Haines is the largest community within the Haines Borough. (*See Figure 3-35, Map of the City of Haines*). As such, much of the discussion in this section will focus on the City of Haines. The community of Klukwan is located north of the City of Haines on the highway but is not in the Haines Borough.

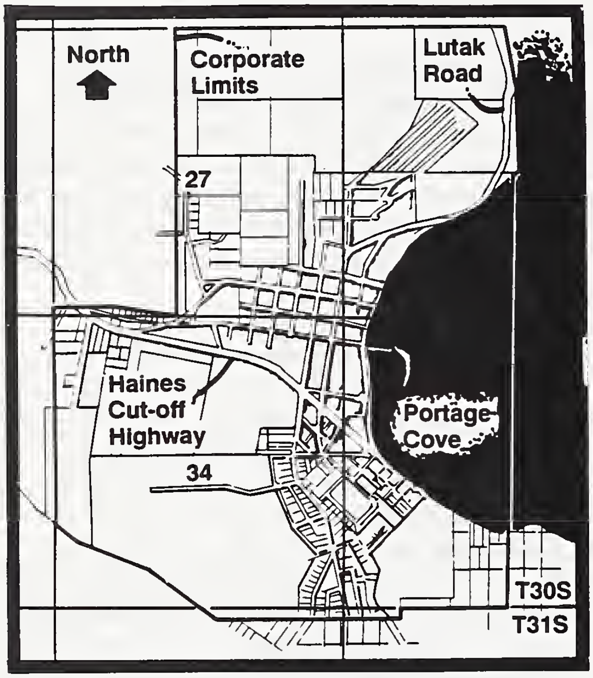


Figure 3-35, Map of the City of Haines

Population/Demography

The population of Haines fluctuates on a seasonal basis. In May of each year, the population begins to increase due to an influx of summer transient and permanent resident populations. The population then decreases with the onset of winter. In the winter, some of the resident population migrates out for winter work while others travel. Peak demands on Haines community services are, therefore, in the summer months. In 1980, the U.S. Bureau of Census reported the population of the Haines Borough to be 1,680 people, up 176 percent in population over the 1970 census. Population trends for the City of Haines are presented in *Table 3-26, Population History - Haines Borough*.

Table 3-26, Population History - Haines Borough

Year	Population	Source
1970	1,504	Federal Census
1974	1,650[1]	City Estimate
1979	1,500	OEDP Physical Count
1980	1,680	Federal Census
1985	2,034	Alaska Dept. of Labor
1988	2,023	Alaska Dept. of Labor
1990	2,115	Federal Census (Preliminary)

Source: The McDowell Group (1990d)
[1]Two timber mills operating and Alaska Pipeline Boom.

Employment

Total employment in the Haines Borough was estimated in 1990 to be 1,163 with City of Haines residents comprising about 40 percent of the Haines Borough total estimated employment or approximately 465 jobs. (*See Table 3-27, Employment Profile for the Haines Borough*).

In 1989, the manufacturing sector of the economy was the largest employer in the Borough of Haines providing approximately 36 percent of total employment. Retail trade accounted for 11 percent of employment while the estimate of commercial fishermen was approximately 10 percent. Employment in the transportation, communication, and utilities industries likewise accounted for 10 percent of the employment. The government sector employed approximately 17 percent of the workers in the Haines Borough. There was no mining related employment cataloged in the Borough of Haines in 1989. (*See Figure 3-36, Percentage Comparison of Average Annual Haines Borough Employment*).

Income

Total annual payroll by industry sector and the average annual wage for each sector for the City of Haines is summarized in *Table 3-28, Haines Non-Agricultural Payroll*. Manufacturing,

Table 3-27, Employment Profile for the Haines Borough (1989)[1]

Employment Category	Number Employed
Construction	35
Manufacturing (Timber/Seafood Processing)	422
Transportation, Communication, & Utilities	117
Retail	129
Finance, Insurance, Real Estate	16
Services	66
Federal	13
State (Full Time Equivalent)	46
Local Government/Schools	143
Miscellaneous/Confidential	61
Commercial Fishermen (1989 Season Estimate)[2]	115
Total Estimated Employment Haines Borough	1,163

Source: City of Haines (1990) from the Alaska Department of Labor, Nov. 16, 1989, and local research and enumeration

[1]City of Haines residents employed are estimated to be about 40 percent of the Haines Borough total estimated employment shown above, or 465 employed jobs.

[2]Not enumerated by the Alaska Department of Labor.

which includes the Chilkoot Lumber Company sawmill and the Excursion Inlet fish packing processing plant, is the largest contributor to the local economy and personal income.

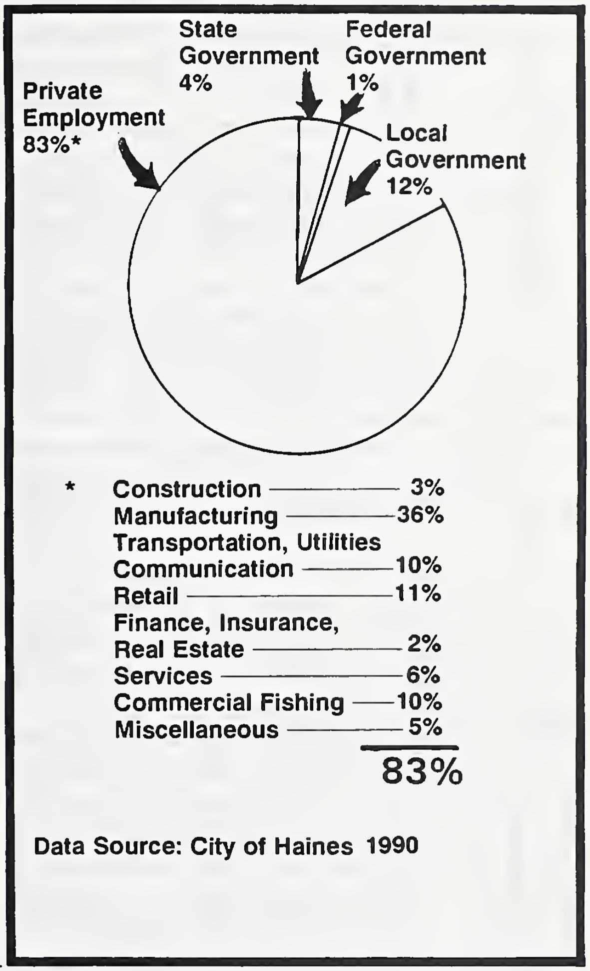


Figure 3-36, Percentage Comparison of Average Annual Haines Borough Employment

Community and Public Services

Community and public services in the City of Haines and Borough of Haines include the following.

- Education
- Law Enforcement
- Fire Protection
- Ambulance
- Hospital and Medical Services
- Mental Health/Drug and Alcohol Treatment
- Water Supply
- Wastewater Treatment
- Solid Waste
- Electric Utilities

Table 3-28, Haines Non-Agricultural Payroll ($X1,000)

Industry	1980	1981	1982	1983	198[illegible]	198[illegible]	1986	1987	198[illegible]	1989
Private Sector										
Mining	0	--[1]	--[1]	--[1]	0	0	0	0	0	0
Construction	--[1]	--[1]	--[1]	$ 705.3	$ 1,038.8	$ 1,055.3	$ 1,005.6	--[1]	--[1]	--[1]
Manufacturing	$1,865.9	$ 2,604.0	--[1]	--[1]	--[1]	--[1]	--[1]	--[1]	$22,636.9	$22,821.3
Transportation,	1,774.2	1,206.3	$ 1,199.3	1,944.3	2,247.9	2,080.3	2,881.1	$ 3,459.8	2,295.9	4,723.2
Communication & Utilities										
Wholesale Trade	--[1]	--[1]	0	0	--[1]	0	0	0	--[1]	--[1]
Retail Trade	966.7	1,171.1	1,298.1	1,333.4	1,401.5	1,595.1	1,584.0	1,468.3	1,705.1	1,971.8
Finance, Insurance and Real	--[1]	312.1	467.0	628.5	716.0	791.4	1,062.5	1,663.1	1,170.1	346.9
Estate										
Services	429.5	464.5	690.1	528.5	572.6	736.7	786.4	860.0	1,150.8	1,255.6
Agricultural, Forestry, Fisheries &	--[1]	--[1]	--[1]	--[1]	--[1]	--[1]	--[1]	--[1]	--[1]	--[1]
Miscellaneous										
Government Sector										
Federal	194.9	195.6	212.4	181.6	287.2	313.4	315.9	320.5	329.2	330.7
State	905.9	1,199.3	1,263.0	1,344.7	1,369.1	1,345.1	1,465.3	1,198.4	1,285.7	1,392.5
Local	1,846.7	2,309.5	2,670.0	2,782.6	2,870.0	3,049.2	2,967.5	2,850.1	2,850.0	2,911.3
Total Payroll	$8,574.3	$10,054.1	$12,463.3	$13,872.3	$16,814.3	$18,647.0	$22,908.2	$27,845.6	$34,588.3	$37,442.9

Source: Data from unpublished Alaska Department of Labor computer files
[1]Not shown to avoid disclosure of data for individual firms.

Education. The Haines Borough School District provides educational services to the community for kindergarten through twelfth grade. All Borough school facilities in Haines are located on a 16-acre site which includes recreational facilities, as well as four buildings: the primary, elementary/junior high, high school, and vocational buildings.

There was a 1989/1990 enrollment of 85 students (kindergarten through second grade) in the primary building. The elementary/junior high building serves third through eighth grades and had 180 students enrolled. In addition to classrooms, the elementary/junior high building has an administrative office, a library/media center, a computer room, a gymnasium, and a multi-purpose room. One wing of the building serves the junior high program (grades 7 and 8).

The high school building was built in 1973 and had 100 students in 1989/1990. This high school includes a fully equipped woodworking shop, swimming pool, gymnasium, and five general classrooms.

A vocational building is operated by the school system for grades nine through twelve. Metal shop, auto mechanics, and art are taught in this building. The Haines Borough School District also operates a correspondence study program with an average enrollment of six.

Enrollment in the Haines School System has dropped from a high of 596 students in the 1973 to 1974 period to a total 365 students currently. Enrollment capacity is considered to be 500 students for quality education, although almost 600 students have been housed successfully. Considering those figures, the Haines school is operating approximately 30 to 40 percent below capacity.

The Haines Borough school facilities are also used by the community for adult and community education classes. These include adult basic education and community college courses taught through the University of Alaska. Adult sport and recreational activities are also available through the Haines Borough school facilities.

The Haines Borough operates another school facility on Mosquito Lake Road at mile 27. It was built in 1982 and currently employs two teachers for 20 students, grade levels kindergarten through four.

At the community of Klukwan, a modern school facility was built in 1984 and provides grade education for 30 students from kindergarten through eighth grade. This school has three classrooms, one library, one office, one multi-purpose room, and one storage room. There are three full-time teachers, one principal/teacher, and one special education teacher. The Klukwan school is within the Chatham School District, rather than the Haines Borough School District, because Klukwan Village lands are an inclusion of Native land within the jurisdictional boundaries of the Haines Borough.

Law Enforcement. The 10-person City of Haines Police Department has responsibility for the City of Haines and two locations outside the City limits, the City owned airport terminal and the Lutak Dock and State Ferry terminal. The Chief of Police for the City of Haines also holds a special commission from the Alaska State Troopers, which permits this individual to act as a law enforcement officer outside the city limits of Haines. The Police Department is located in the Municipal Building and consists of two squad rooms, the chief's office, and three jail cells. Each cell is capable of accommodating four temporary prisoners (maximum of 12) or two prisoners serving sentences (maximum of 6). The department is comprised of a full-time chief, four full-time officers, and five dispatchers (who also serve the fire department). The current police force provides 24 hours per day, 7 days a week law enforcement protection for the community.

Fire Protection. The City of Haines volunteer fire department is housed in the municipal building and has a volunteer force of 28 trained firefighters and one full-time paid city firefighter. Dispatching is handled by the five person central dispatching staff for police, fire, and other emergencies through the 911 emergency telephone number. A secondary radio communication system is available in the fire hall in case of failure of the main police department communication system. The Haines

Volunteer Fire Department provides full service fire protection within several fire service areas located in the Haines Borough and within the corporate limits.

Pump truck capacity is sufficient for current community requirements. However, future population growth would require additional fire department personnel and additional equipment. Increased water storage capacity, and larger water lines would be required to lower the city's insurance rating, which would mean lower fire insurance rates and increased public safety.

Ambulance. Ambulance service is also provided by the Haines Fire Department. There are nine volunteer personnel who serve on the ambulance.

Hospital and Medical Services. The Haines Medical Center is operated by Lynn Canal Medical Corporation and serves the medical needs of the community. This facility is staffed by one physician with several backup, part-time physicians, several registered nurses, and various clerical staff. The Center is equipped for physical examinations, limited emergency treatment, pharmaceutical services, X-Ray analysis, laboratory analysis, immunizations, vision screening, and minor surgery. The services available at the Haines Medical Center are not as extensive as those at a full service hospital. Patients requiring care not available in Haines are sent or transported to Juneau, Seattle, or Whitehorse.

The Haines Medical Center also provides a general service dentist office, operated by a dentist, two dental technicians, and a secretary. Monthly visits by an oral surgeon are supported by this office. The Haines dentist also visits Skagway. Patients requiring dental services beyond those provided in Haines are referred to Whitehorse, Juneau, or Seattle.

The Alaska Department of Health and Social Services employs a full time public health nurse in Haines. This office provides the following basic services for the prevention of diseases and promotion of public health: immunization, prenatal classes and follow-up care, screening for disease prevention, referral to other social services in the community, and office support for visiting specialists and nursing practitioners. The public health nurse also visits Skagway and Yakutat on a regular basis. Services are free for individuals up to 20 years of age. Fees are charged to adults on an ability to pay basis.

Mental Health/Drug and Alcohol Treatment. Mental health services are provided by Lynn Canal Mental Health Program under contract to the Alaska Department of Health and Social Services, Division of Mental Health. Offices are located in the City of Haines Human Resources Building. Staffing consists of one director, one office manager, and one clinician (located in Skagway). The office also supports periodic visits by a psychologist and a psychiatrist from Juneau. Klukwan and Skagway also are supported by this office. Future needs for the community identified by Lynn Canal Mental Health Program are a home for the disabled, senior citizens, and the chronically mentally ill.

The Southeast Alaska Regional Health Corporation, a Native corporation, employs an alcohol and drug counselor, as well as a community family service worker who provides services under the Women and Infant Children Program. There is a separate Southeast Alaska Regional Health Corporation office for Klukwan. Health education outreach and mental health counseling services also are provided.

Water Supply. The public water system for the City of Haines is gravity distributed to 314 residential and 132 commercial customers. Water is obtained from Lily Lake. The system is capable of delivering an estimated 500 gpm. The current consumption for the City of Haines varies from approximately 400 gpm in the summer to 160 gpm in the winter.

Water for the City of Haines is stored in a 100,000 gallon storage tank at Young Road and Barnett Drive, a 320,000 storage tank on the Bartlett Road in the Port Chilkoot Subdivision, and a 50,000 gallon tank above the Highlands Estates Subdivision.

The City of Haines water system is presently close to its capacity during summer months. Higher summer demand is due in part to an increased summer transient population, summer tourists, and three new RV parks in the area. There are three filter units in service at the water treatment plant. It is anticipated that another

filter unit would have to be added to account for projected future summer time high demand loads.

Wastewater Treatment. The City of Haines owns and operates a package wastewater treatment plant which utilizes an activated sludge process to provide secondary treatment. The system was built in 1974 and has a current treatment capacity of 150,000 gallons per day which is adequate to service a population of approximately 1,500 people. The plant provides for 85 percent removal of solids and the resultant effluent is treated and discharged to tidewater.

The sewer system and plant were extensively rehabilitated in the mid 1980s. The rehabilitation was required because of inflow and infiltration problems created by high water table in the low lying areas combined with the fluid pressure at high tide along Beach Road. Currently, high seasonal rains can still cause continuing inflow and infiltration problems. Up to 1,500,000 gallons per day of inflow and infiltration have impacted the system periodically. During these episodes, high water outflow is directly bypassed at the Tlingit Park Pump Station into Portage Cove and at the extreme south end of the system along Beach Road.

The City of Haines sewer system is currently operating under a 301(H) waiver from the EPA. This waiver was issued in 1982 and will expire in 1991. Section 301 (H) of the Clean Water Act authorizes municipalities to discharge effluent without secondary treatment. Primary treatment is still required.

The City has hired an engineer to design system improvements sufficient to meet new EPA requirements, elimination of high inflow and infiltration bypasses, and reduction in the inflow and infiltration within the system.
The new design work by the engineer will also consider future demands on the system from possible community growth.

Solid Waste. The Haines Sanitation Company, a private contractor, provides solid waste collection and disposal under a franchise agreement with the City of Haines. Solid waste is disposed at a sanitary landfill located on a 10 acre tract of land approximately 1 mile southeast of the city limits. The City sold the land to the Haines Sanitation Company for development and operation of the city sanitary landfill. All onsite equipment is owned by the Haines Sanitation Company.

The present landfill site has been in use since 1976 and has an expected total life of 20 to 25 years. The City owns an adjacent 10-acre tract of land for further expansion.

Electric Utilities. Electric power for Haines and the surrounding area is supplied by the Haines Light & Power Company (HL&P), a privately owned utility that is a wholly owned subsidiary of the Alaska Electric Light & Power Company located in Juneau. The peak load capacity of 4,210 kilowatts (kw) is presently produced by six diesel electric generators with ratings that range from 800 kw to 150 kw. HL&P serves approximately 900 residential, commercial, and industrial customers. Average demand is estimated at 1,000 to 1,100 kw during the summer and approximately 1,500 to 2,000 kw during the winter.

The existing system is adequate to supply current needs and could safely accommodate a 50 percent increase in the number of customers.

Housing

Haines housing stock data is available from several sources though much of the information is out-of-date. Because of social and economic change in Haines, data compiled in the 1980 Census is of little value. A 1985 survey performed by the Tlingit & Haida Regional Council found 440 occupied housing units within the City limits including 92 vacant units. A 1988 survey performed by the Haines Borough counted 32 single family units (including 8 vacant units) and 82 multifamily units (including 5 vacancies) within the City limits. The U.S. Bureau of Census counted 527 housing units in the City of Haines and 1,112 housing units within the Borough in 1990.

The Haines Borough assessor has recorded a total of 644 residential properties, 11 mobile homes, three apartment buildings, and three farms in the Borough. The residential properties have a total assessed value of $37.5 million.

The average assessed value is about $58,000 but this includes a wide range of housing in terms of location, lot and building size, and quality.

According to unofficial sources in Haines, the demand for rental housing in particular is not matched by the supply. Newcomers to Haines report having difficulty finding suitable housing. In the May 31, 1990 edition of the Chilkat Valley News (the Haines newspaper), a $100 reward was offered to anyone finding a two or three bedroom house or apartment for rent.

The market for home buyers is apparently not as tight as the rental market. Seven to ten single family homes have been advertised recently in the local newspaper and by real estate agencies. Prices vary widely depending on size, location, and quality of construction.

The Haines area includes extensive private land holdings. According to the Assessor's office, there are 1,021 vacant parcels in the Borough. Unlike many other Southeast Alaska communities, Haines has a large inventory of vacant privately held land within a short distance of the downtown area. Much of this land is available for purchase and/or residential development. The Juneau Multiple Listing Service, which lists some Haines area properties, lists 15 lots ranging in size from small building lots to a 135-acre parcel. Many other unadvertised subdivision parcels are for sale with prices ranging from $10,000 to $30,000. Waterfront lots have recently sold for higher prices.

Comparatively low-cost housing construction is available in Haines. While residential construction costs in Juneau are over $80 per square foot, construction costs in Haines are about $65 per square foot depending on the quality of the building.

Fiscal Condition

The City of Haines assesses a 4 percent sales tax and the Haines Borough assesses an additional 1 percent sales tax. In FY 1989 (year ended June 30, 1989), the City collected about $785,000 and the Borough about $213,000. Twenty-five percent of the City's sales tax revenues are dedicated to tourism promotion, 37.5 percent is dedicated to capital improvement projects, and the remaining 37.5 percent to the general fund (City of Haines, 1990).

The City of Haines levies an 8.5 mil property tax on an assessed property value of $43.6 million. The Borough assesses a 4 mil property tax on a total property value of $89.6 million. The Borough property tax revenue is dedicated to public school finance.

The City of Haines revenues and expenditures for FY 1989 are presented in *Table 3-29, City of Haines Revenues and Expenditures, FY 1989*.

The City of Haines manages enterprise funds for water, sewer, and small boat harbor operations. Enterprise fund revenues totaled $360,880 while operating expenses totaled $489,829 including depreciation of assets.

The City of Haines has bonded indebtedness in the form of General Obligation bonds totaling $480,000 payable through the year 2009 and LID bonds totaling $200,000 payable through the year 2010. The City also has annual payments of $28,085 through 1992 for purchase of heavy equipment.

The Haines Borough generated approximately $4.1 million in revenues during FY 1989 and had expenditures of approximately $4.0 million in expenditures. Eighty percent of Borough spending was on public school operations with the balance spent on general administration, cultural facilities, debt service, and capital projects. The Borough has total bonded indebtedness of about $282,000 (from high school construction) which will be retired over the next 3 years (City of Haines, 1990).

Recreation

Athletic facilities in Haines include the swimming pool, two gymnasiums, a tennis court, a running track, and a baseball field. The Chilkat Center for the Arts houses a theater and KHNS, the local public radio station. Haines also has a museum. Tlingit Park, three state campgrounds, the fairgrounds, and Lookout Park provide outdoor recreational opportunities. There are numerous hiking trails of varying degrees of difficulty in the area. Boaters are

Table 3-29, City of Haines Revenues and Expenditures, FY 1989

Sources of Revenue		Items of Expenditure	
State Municipal Assistance, Revenue Sharing, Other	$253,178	General Government Operations	
Capital Projects		Administration	$284,013
Federal	39,705	Building Maintenance	19,402
State	215,200	Municipal Dock	47,449
Local Sales Tax	294,308	Civic Support	4,918
Special Revenue		Capital Projects	51,327
Sales Tax - Tourism	196,463	Elections	1,450
Other Local	1,075	Public Safety	
State	72,041	Police	334,885
Local Taxes to General Fund		Fire	115,760
Property tax	396,764	Ambulance	15,384
Sales Tax	294,308	Public Works - Water & Sewer Operation	238,196
Special Assessments	31,728	Economic Development and Assistance	
Charges for City Services		Tourism	152,795
Fire	34,903	Coastal Zone Management	11,746
Harbor Fees	102,925	Economic Development	15,788
Fines and Fees	5,682	Day Care Assistance	31,490
Interest, Rent and Other	118,517	Litter and Recycling	1,075
		Debt Service	141,362
		Purchase of Fixed Assets	155,016
		Capital Projects	284,912
Total Revenues	$2,056,797	Total Expenditures	$1,906,968

Source: The McDowell Group (1990d)

served by the Small Boat Harbor and Letnikof Cove Boat Harbor and launching ramp.

Transportation

Haines is one of the most accessible communities in Alaska, with scheduled air and ferry service as well as a road link to the Alaska Highway System.

Before the Klondike highway was opened for year-round use, the Shakwak Highway (known as the Haines highway) was the only road link between Southeast Alaska and the Alaska-Canada highway system. The issue of road construction between Juneau and Haines is again receiving political attention. The Alaska Department of Transportation and Public Facilities is currently preparing an Environmental Impact Statement for a variety of Juneau access alternatives including a highway to Haines.

The Alaska Marine Highway System provides passenger and vehicle service to Haines approximately five times per week. The ferry uses the Lutak Dock, which it shares with the City of Haines. Haines also has a second marine facility, the Port Chilkoot dock located in the downtown area. Presently, ferry schedules and capacity to Haines are more than adequate to meet the off-season demand. However, during the summer, vehicle space is frequently booked long in advance. Details on passenger and vehicle volumes are provided in The McDowell Group (1990d).

General cargo is delivered weekly to Haines by an Alaska Marine Lines barge. The barge uses the Lutak Dock. A fuel barge stops at Haines on a monthly basis.

Haines air traffic is served by a 4,200 foot State-owned asphalt runway. No air traffic control is provided at the airport, which serves primarily small single and twin engine aircraft. The airport is managed by the Alaska Department of Transportation, which is currently planning a major expansion and airport upgrade.

In 1989 there were approximately 17,200 aircraft operations (take-offs and landings) at the Haines Airport. An estimated 20,000 passengers boarded regularly scheduled or charter flights in Haines last year. Wings of Alaska, Haines Airways, Skagway Air, and LAB provide scheduled air service to Haines. There

are a number of fixed-wing and rotary aircraft charter operators based in other communities that serve Haines as well.

CITY OF SKAGWAY

The combination of a deepwater port and good access to the Yukon Territory accounts for Skagway's long history as a trans-shipment center. Gold seekers streamed through Skagway on foot or by railroad at the beginning of the century. After the gold rush, the railroad became the chief employer in the small town. It hauled ore from Yukon mines to tidewater. The railroad dominated the local economy until its closure in 1982, which resulted from the shut-down of the Cyprus Anvil lead/zinc mine in Faro, Canada.

By the time the railroad closed, the town was well on its way to diversifying its economy. In 1976, the Klondike Gold Rush National Historical Park was authorized and funded by the U.S. Congress. As a result money was appropriated to restore the historic downtown area. Tourism was given another boost when the Klondike Highway opened in 1978. Skagway is a frequent stop for cruise ships. Tourism has become the largest employer in Skagway. In 1988 the Whitepass and Yukon Railroad was reopened as a tourist attraction.

Trans-shipment remains an important element in Skagway's economy. The Klondike Highway was opened for year-round use in 1986. A new company, Curragh Resources, has taken over the Faro mine, and now lead/zinc concentrate (an estimated 500,000 tons in 1987) is trucked in to an ore terminal facility in Skagway. There is a fuel pipeline connecting Skagway with Whitehorse, and the White Pass terminal in Skagway includes a bulk storage tank farm.

Skagway became the first incorporated city in Alaska in 1900. Today it is a first class city, with a City Manager. There is no Borough government in the area. The City of Skagway governs approximately 443 square miles of land, including the town of Dyea, a once-booming gold rush town that now has only a handful of residents.

Population/Demography

At the time it was incorporated in 1900, Skagway had approximately 3,000 residents. By 1909, as the gold rush waned, the population was down to 872 and still shrinking. Population has declined somewhat since the 1980 census due both to the closure of the railroad in 1982 and the statewide recession of 1986 and 1987. (*See Table 3-30, Skagway Population*).

Table 3-30, Skagway Population

Year	Population
1980	814
1986	736
1988	704
1990	692

Source: Alaska Department of Labor, U.S. Department of Commerce, Bureau of the Census

Although Skagway got its name from the Tlingit Indians, who called it "Skagua", the town does not have a large Native population. The 1980 census showed 6 percent of the population as Native; in 1970 the percentage was 7 percent. Skagway does not have an Alaska Native Claims Settlement Act village corporation.

Employment

Employment and payroll data for Skagway are not regularly published by government agencies. Because it is a small community, it is lumped together with Yakutat and Angoon in one census area. A limited amount of Skagway-specific data is available, at the statistical sub-area level, from the Alaska Department of Labor. This data, however, must be viewed cautiously because it includes only those employees covered under the State unemployment insurance system. Data from at least one employer, the White Pass and Yukon Route Company, is not included. Data for four out of 10 industrial categories is not available because of confidentiality restrictions. (*See Table 3-31, Skagway Non-Agricultural Employment*).

The *Skagway Comprehensive Plan* describes results of employment surveys conducted in

Table 3-31, Skagway Non-Agricultural Employment

Industry	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Private Sector										
Mining	0	0	0	0	0	0	0	0	0	0
Construction	–[1]	–[1]	–[1]	–[1]	–[1]	–[1]	–[1]	–[1]	–[1]	–[1]
Manufacturing	–[1]	0	0	0	0	0	0	0	–[1]	–[1]
Transportation, Communications & Utilities	67	70	75	78	79	76	78	67	59	70
Wholesale Trade	0	0	0	0	0	0	–[1]	–[1]	–[1]	–[1]
Retail Trade	55	66	64	62	70	75	–[1]	–[1]	–[1]	99
Finance, Insurance, & Real Estate Services	10	11	12	–[1]	–[1]	–[1]	–[1]	–[1]	–[1]	–[1]
Agriculture, Forestry, Fisheries & Miscellaneous	–[1]	–[1]	–[1]	–[1]	–[1]	56	–[1]	93	66	66
Government Sector										
Federal	11	11	9	8	31	35	35	40	35	35
State	22	23	25	27	32	33	32	31	34	35
Local	57	47	51	48	45	43	41	41	44	40
Total Employment	295	299	314	295	333	330	–[1]	–[1]	–[1]	397

Source: Data from unpublished Alaska Department of Labor computer files
[1]Not shown to avoid disclosure of data for individual firms.

1980 and 1987 for the community. These surveys found that total employment has increased from 347 in 1980 to 627 in 1987, with dramatic growth in retail trade and service sector employment. This effort measured the total number of jobs, rather than full-time equivalent employment, so the results are not comparable with Department of Labor data. The actual number of transportation jobs changed very little, dropping from 152 in 1980 to 145 in 1987. However, the relative importance of these jobs in the economy decreased considerably, from 44 percent to 23 percent of total employment. Data for 1980 on employment status was not included in the Comprehensive Plan. Data on employment status for 1987 revealed that only 36 percent of those employed held year-round jobs, and only 27 percent held full-time year-round jobs. The rest of the employment was seasonal.

Unemployment figures for Skagway are lumped together with those of Yakutat and Angoon. Both Yakutat and Angoon have historically had high rates of unemployment. Therefore, skewing the census area average which may not be representative of Skagway. (*See Table 3-32, Average Annual Unemployment Rate in the Skagway-Yakutat-Angoon Census Area*). The actual unemployment rate in the City of Skagway is probably lower than the district average. The seasonal nature of Skagway's economy, however, is well portrayed in *Table 3-33, Average Monthly Unemployment Rate in the Skagway-Yakutat-Angoon Census Area*. Unemployment in Skagway is highest during the winter months and lowest during the summer months when the tourism industry is at its height.

Table 3-32, Average Annual Unemployment Rate in the Skagway-Yakutat-Angoon Census Area

Year	Unemployment
1980	12.5%
1981	14.0%
1982	13.4%
1983	20.2%
1984	15.2%
1985	13.8%
1986	16.8%
1987	17.3%
1988	15.8%
1989	12.8%

Source: Alaska Department of Labor, Alaska Economic Trends, various issues and news releases

Table 3-33, Average Monthly Unemployment Rate in the Skagway-Yakutat-Angoon Census Area

Month	Unemployment
April 1989	15.6%
May	14.8%
June	10.8%
July	8.1%
August	8.1%
September	7.3%
October	11.7%
November	12.5%
December	13.7%
January 1990	20.5%
February	22.0%
March	17.3%

Source: Alaska Department of Labor, Alaska Economic Trends, various issues and news releases

Unemployment in the Skagway/Yakutat/Angoon census area was very high throughout most of the 1980s. However, the employment picture brightened considerably in 1989 when the unemployment rate dropped to 12.8 percent, the lowest level since 1980.

Income

Annual payroll in Skagway totaled over $11 million in 1989 with over 60 percent of the total earned during the second and third quarters. (*See Table 3-34, Total Non-Agricultural Payroll in Skagway by Industry*). Government generates about 40 percent of all payroll in Skagway. The transportation, communications and utilities category accounts for most of the private sector earnings ($1.5 million annually). This category includes port operations and visitor-related transport services. Other visitor affected sectors include Retail Trade ($1.3 million in payroll) and Services ($1.1 million).

Community and Public Services

Community and public services in the City of Skagway include the following.

- Education
- Law Enforcement
- Fire Protection and Ambulance
- Health Services
- Water Supply, Wastewater Treatment, and Solid Waste Disposal
- Electric Utilities

Education. The Skagway School District provides public education to the community's

Table 3-34, Total Non-Agricultural Payroll in Skagway by Industry ($x1000)

	1987	1988	1989
Construction	--[1]	--[1]	--[1]
Manufacturing	--[1]	--[1]	--[1]
Transportation, Communication & Utilities	$1,439	$1,581	$ 1,497
Retail Trade	--[1]	--[1]	1,289
Finance, Insurance & Real Estate	--[1]	--[1]	--[1]
Services	892	978	1,097
Agriculture, Fishing and Miscellaneous	--[1]	--[1]	--[1]
Federal Government	1,116	1,068	972
State Government	976	1,116	1,227
Local Government	1,144	1,176	1,040
Total (excluding non-insured)	--[1]	--[1]	$11,383

Source: Data from unpublished Alaska Department of Labor computer files
[1]Not shown to avoid disclosure of data for individual firms.

144 school age children. School District management is provided by a five-member, elected School Board. The School District operates on a budget of $1 million with the State of Alaska providing over 90 percent of School District funding.

Skagway has one school, built in 1985, which services students kindergarten through grade 12. In the 1989-90 school year, there were 144 students enrolled, 75 at the elementary level and 69 in junior high and high school. Total design capacity for the building is 199 students. The school has five elementary teachers, eight junior and senior high school teachers, an administrator, and six classified staff. The student/teacher ratio is 11 to 1.

The Skagway School District also provides community education opportunities for all ages. A part-time director and a member advisory board managed community education activities for over 1,500 participants. The program relies heavily on the efforts of volunteer assistants.

Law Enforcement. The Skagway Police Department provides public safety for a 443 square-mile area with a force of four full-time officers. The FY 1990 Police Department budget was $208,000. According to the Skagway Comprehensive Plan (City of Skagway, 1988), the Police Department is operating with insufficient administrative space and holding facilities.

There is no state police presence in Skagway. State law is enforced by the Skagway Police Department and a State District Court magistrate for the First Judicial District handles arraignments and preliminary hearings. Skagway does not have the facilities to hold state felons. Convicted felons must either be transferred to Juneau or released on their own recognizance.

Federal law enforcement agencies active in the Skagway area includes U.S. Customs and Immigration which enforce international transport of materials and passengers through Skagway. The National Park Service enforces federal regulations within the Klondike Gold Rush National Historical Park.

Fire Protection and Ambulance. Fire suppression and emergency medical response Is provided by the Skagway Volunteer Fire Department. The Department has one paid employee, 17 volunteer firefighters, and nine volunteer Emergency Medical Technicians. The Department also provides rescue services, fire and medical training, fire prevention education, building plan review, building fire inspections, and disaster response planning. An average of about 20 fire suppression calls are received each year. Emergency medical calls average about 40 a year.

There is one fire station, equipped with seven pumper/tanker trucks. The Department also has one ambulance, and two utility trucks. The Fire Department budget for FY 1990 was $79,000.

While the Department is capable of meeting the residential demands for fire suppression services, it is not sufficiently equipped to met commercial and industrial demands according to the Skagway Comprehensive Plan (City of Skagway, 1988).

Health Services. Health services in Skagway consist of a two-bed medical clinic staffed by two physicians assistants (one is there during the summer season only). A private physician from Haines offers scheduled, weekly visits. The Clinic provides basic medical care, 24-hour emergency service, and limited pharmaceutical services. Patients requiring services not available at the Clinic are transferred to facilities in Juneau or Whitehorse. Other services provided by the Clinic include family practice, mental health counseling, and regular visits by the Public Health Nurse, an optometrist, and a dentist.

Health services funding is provided by the City of Skagway and by the Alaska State Department of Health and Social Services. The City of Skagway budgeted $42,000 for health care services in FY 1990.

Water Supply, Wastewater Treatment, and Solid Waste Disposal. The City of Skagway operates the water, sewer, and waste disposal services. Water comes from an aquifer below the Skagway River which is tapped by three wells. The average daily demand for water in

Skagway is about 200,000 gallons. Summertime demand increases to about 600,000 gallons per day. Currently, the water utility is financed through an enterprise fund, which means the users pay the cost of supply and distribution of water. At this time, user fees do not, however, cover the cost of major capital replacement. About 90 percent of Skagway's residents are on the water system.

Sewage treatment is minimal; waste is screened, then discharged into the Taiya Inlet. Past efforts to develop secondary treatment facilities have been unsuccessful because of high costs and operational difficulties. Sewer system flow averages from about 250,000 gallons per day in the winter to about 350,00 gallons per day in the summer.

Solid waste is disposed in a city-owned landfill recently permitted under ADEC regulations.

Electric Utilities. Electricity is supplied by the Alaska Power and Telephone Company. Diesel and hydro power generate the electricity. Generator capacity is 4,480 kw. Peak demand in 1988 was 1,540 kw.

Housing

The U.S. Bureau of the Census counted 404 housing units in Skagway in 1990.

Fiscal Conditions

The City of Skagway is a first class city with a City Manager. The City provides education and public safety services, water, sewer, solid waste disposal and a variety of other services to local residents and visitors. The City collects both a sales tax and a property tax.

In FY 1990, the City of Skagway's general fund budget amounted to just over $1 million. (*See Table 3-35, City of Skagway General Fund Revenues and Expenses*). Besides the general fund, there are garbage, water, port enterprise, special sales tax, debt service, tourism, equipment replacement, and land sale funds.

Recreation

Community recreation facilities provided by the City include a ball field, several parks with picnic areas, outdoor tennis and basketball courts, playground facilities, trails to nearby lakes and other destination points, and a small boat harbor. School facilities also are available to the community when not being used by students. School facilities are particularly important in the winter since the school has the only gymnasium in the community. Cross country skiing, snowshoeing, and other winter activities are available in nearby mountains (Lawson, 1990).

Table 3-35, City of Skagway General Fund Revenues and Expenses (Fiscal Year 1990) ($x1,000)

General Fund Revenues	
Taxes	$356
State and Federal Sources	183
Rentals and Leases	61
Fines	7
Licenses and Permits	8
Admissions	68
Interest and Penalties	104
Charges for Services	19
Interfund Transfers	276
Total	$1,082
General Fund Expenses	
City Hall	$12
City Manager	63
City Clerk	99
Council	49
Administration	303
Fire Department	79
Police Department	208
Parks and Recreation	18
Fish Hatchery	13
Health Center	42
Public Works	107
Museum	42
Library	47
Total	$1,082

Source: The McDowell Group (1990d)

Transportation

The Klondike Highway, which links Skagway to the Alaska Highway system, was opened to year-round traffic in 1986. It provides road access for trucks carrying approximately 500,000 tons of lead/zinc concentrate annually

from Faro, Yukon Territory. The road satisfies a transportation need that was formerly met by the railroad. The highway also has made Skagway more accessible to travelers. According to the Alaska Visitor Statistics Program, more than 50,000 people arrived in Skagway via this highway in the summer of 1989, about 8 percent in motorcoaches (buses) and the rest in personal vehicles (The McDowell Group, 1990d).

Skagway is the northern terminus of the Alaska Marine Highway System. The ferry provides service year-round, with daily stops in the summer and five stops weekly in the winter. Passenger and vehicle traffic on the ferry has increased considerably since the Klondike Highway was opened for year-round use.

Alaska Marine Lines provides weekly scheduled barge service to Skagway from Seattle, the City's principal supply center. White Pass ships goods and fuel from Vancouver on a bi-weekly basis. Lead/zinc ore, brought in from the Yukon Territory, is shipped out of Skagway on ore ships that arrive every other week.

Between 220 to 240 cruise ships visit Skagway from May through September bringing 120,000 to 200,000 visitors.

Skagway has a community airport, with a 3,750 foot paved runway and a terminal, owned and operated by the State of Alaska. Three airlines, Skagway Air, Wings of Alaska, and LAB provide 19 scheduled daily flights in the summer, and eight in the winter. Charter service is provided by a variety of carriers.

SUBSISTENCE

BACKGROUND

Subsistence refers to the customary and traditional uses of fish and game and other renewable natural resources by rural Alaska residents.

Section 803 of the Alaska National Interest Lands Conservation Act (ANILCA) defines subsistence uses as:

> "The customary and traditional uses by rural Alaska residents of wild, renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation; for the making and selling of handicraft articles out of the noneatable byproducts of fish and wildlife resources taken for personal or family consumption; for barter, or sharing for personal or family consumption; and for customary trade."

The harvest and use of subsistence resources are important to rural Alaska residents for a number of reasons including 1) locally available renewable natural resources are less expensive than, and often nutritionally superior to, store purchased products; 2) subsistence resources can be a supplement to or a partial replacement for income derived through seasonal employment; and 3) harvest, use and redistribution of subsistence resources is considered an integral part of the cultures and social value systems of many rural and indigenous Alaskans. Thus, subsistence resource harvest is viewed in terms of food value, a component of evolved modern economic strategy, and as a critical focus of integral cultural and social value systems.

Section 810 of ANILCA requires a federal agency, having jurisdiction over lands in Alaska, to evaluate the potential effects of proposed land-use activities on subsistence uses and needs. Section 810 of ANILCA states:

> In determining whether to withdraw, lease, or otherwise permit the use, occupancy, or disposition of public lands under any provisions of law authorizing such actions, the head of the agency having primary disposition over such lands or his designee shall evaluate the effect of such use, occupancy, or disposition on subsistence uses and needs, the availability of other lands for purpose sought to be achieved, and other alternatives which would reduce or eliminate the use, occupancy or disposition of public lands needed for subsistence purposes. No such withdrawal, reservation, lease, permit, or other use, occupancy or disposition of such lands which may significantly restrict subsistence uses shall be effected until the head of the agency:

(1) gives notice to the appropriate State agency and appropriate local committees and regional councils established pursuant to ANILCA Section 805;

(2) gives notice of, and holds, a hearing in the vicinity of the area involved; and

(3) determines that (A) such a significant restriction of subsistence uses is necessary, consistent with sound management principles for the utilization of the public lands; (B) the proposed activity will involve the minimal amount of public lands necessary to accomplish the purposes of such use, occupancy, or other disposition; and (C) reasonable steps will be taken to minimize adverse impacts upon subsistence uses and resources resulting from such action.

(Public Law 96-487, Dec.2. 1980)

The Kensington Gold Project is located within the City and Borough of Juneau. Residents of the City and Borough of Juneau are classified as non-rural and do not qualify as subsistence users under ANILCA. Fishing and hunting by City and Borough of Juneau residents are considered sport and personal use activities regulated by the ADF&G.

RESOURCES AND COMPETITION

The marine environment of southeast Alaska contains marine mammals, halibut, herring, eulachon and all five northwestern species of salmon as well as shellfish and other intertidal species such as crab. These are all considered prime species sought for subsistence.

Terrestrial animals harvested include two species of bear, Sitka black-tailed deer, moose, mountain goat and furbearers. Deer account for a significant amount (approximately 21 percent) of the edible pounds of subsistence resources harvested by southeast Alaska communities (ADF&G, 1991). Sitka black-tailed deer are not common within the Kensington project area.

Three types of birds are recognized as important to subsistence: gulls, kittiwakes and terns (USFWS 1988). These bird types; whose eggs are collected by Native Americans, do not nest in the Kensington project area.

Competition for subsistence resources, primarily deer, is a result of various factors such as fish and game regulations, mobility, the natural distribution of game across Tongass National Forest Lands, decreases in resource populations as a result of habitat reductions, decreases in resource populations as a result of overharvest, and access provided to all rural communities in the form of roads, Alaska Marine Highway System and commercial air carriers. These factors and the fact that the majority of the population (Juneau and Ketchikan residents) residing in non-rural designated communities, result in competition for the more abundant wildlife and fisheries resources around rural areas (USDA Forest Service, 1991b.)

Deer harvest by Juneau residents was included in the Tongass Land Management Plan (TLMP) analysis (USDA Forest Service, 1991b). Information sources were ADF&G 1989 Deer Hunter Survey Statistics and the Forest Service FORPLAN Analysis (June, 1991). The data shows that Juneau residents successfully harvested deer on 59 Wildlife Analysis Areas (WAAs). The number of documented deer harvested by CBJ residents per WAA ranged from 5 to 296. In 1989, subsistence hunters could harvest 6 deer each in all WAAs in Game Region 4 (Admiralty, Baranof and Chichagof Islands). Non-subsistence hunters could harvest 3 deer each on northeast Chichagof Island and 6 deer each in the remainder of Game Region 4 (ADF&G, 1991).

The cooperative Deer model, jointly developed by the Forest Service and ADF&G, recommended 10 percent of habitat capability as a harvest limit. This recommendation is somewhat controversial. It has been suggested that a 20 percent harvest would accomplish the same deer herd management goals. Review and analysis of the 1989 deer harvest data indicates that there is overharvest on 36 of the 59 (61 percent) WAAs used by CBJ/non-subsistence hunters, based on the currently recommended 10 percent harvest limit (ACZ, 1991a). If the analysis reflects a 20 percent harvest limit, then 21 of the 59 (35 percent) WAAs used by CBJ/non-subsistence hunters experienced overharvesting. Further review of

the data shows that significant un-used harvest capacity exists in other WAAs.

AREA SUBSISTENCE USE

While it can generally be said that much of the entire Alaskan Northwest Coast has at one time been used by Alaska natives (as evidenced by archaeological sites) more specific area use is more difficult to assess. Berners Bay and its associated rivers and streams were the traditional territory of the Auk' Tlingit at the time of contact. Their northern boundary falls somewhere between the mouth of Berners Bay and the vicinity of Kataguni Island about thirty miles to the north (Goldschmidt and Haas, 1946; Olson, 1967; Niblack, 1970; de Laguna, 1972; Krause, 1976; Sackett, 1979; Arndt, Sackett, and Ketz, 1987).

The Berners Bay area, while used for limited resources in the past, does not appear to have been used as a subsistence area for many years. Past use of Berners Bay by the Auk' Tlingit centered around the harvesting of berries, and to a lesser degree, hunting and fishing. The Bay was also remembered as connoting a border between the Chilkat and Auk' Tlingit. At least two permanent villages have been remembered at Berners Bay (Goldschmidt and Haas, 1946), although archaeological records and recollections, some in need of physical evidence, might suggest more (Hall, 1988).

For larger game, namely moose, mountain goat, and black bear, there are no recalled customary uses of Berners Bay. The bay does receive limited trapping attention for furbearers. However, harvest figures are low, and it is not clear if these animals are taken under subsistence premises (Hall, 1991a).

Thus, it appears that the area of the proposed Kensington Project is not located in a region of prime subsistence territory, past or present. The area is a component of traditional borders, and only Berners Bay has been of lesser importance to regional subsistence practices. Little or no recent subsistence activities have been practiced in the Berners Bay region, or by extension, the stretch of shore immediately to the northwest (Hall, 1991a).

LAND USE

The project and adjacent area is classified as a LUD II (Land Use Designation) by the Forest Service in the Tongass Land Management Plan as amended during the winter of 1985-86. The focus of this designation is to retain the wildland character of an area (*See Insert on LUD II Designation*).

LAND USE DESIGNATION II

PURPOSE. *Areas allocated to LUD II are to be managed in a roadless state to retain their wildland character, but this would permit wildlife and fish habitat improvement and primitive recreational facility development.*

MANAGEMENT IMPLICATIONS. *Commercial timber harvesting is not permitted. Timber can be salvaged only to prevent significant damage to other resources. Examples are removal of windfall in an important fish stream or control of an epidemic insect infestation.*

Personal use of wood is allowed for cabin logs, firewood, float logs, trolling poles, and other similar uses.

Water and power developments are permitted if they can be designed to retain the overall primitive characteristics of the allocated area.

Roads will not be built except to serve authorized activities such as mining, power and water developments, aquaculture developments, transportation needs determined by the State of Alaska, and vital forest transportation system linkages.

Mineral development is subject to existing laws and regulations.

Use of snowmachines, motorboats and airplanes on freshwater is permitted; however, restrictions may be imposed on a case-by-case basis if such use becomes excessive.

Permanent improvements such as fishways, fish hatcheries, or aquaculture sites may be built. Appropriate landscape management techniques will be applied in the design and construction of such improvements to minimize impacts on recreation resources.

Major concentrated recreational facilities will generally be excluded.

Mineral development is allowed on LUD II areas subject to existing laws and regulations. Historically, the project area has been subject to both mining and milling activities.

NOISE

People can detect and respond to a wide range of sound intensities and frequencies. A logarithmic "decibel" scale is used to quantify sound intensities. Our ability to hear sound depends greatly on the frequency of the sound. To measure sound on a scale that approximates the way people hear, more weight must be given to those frequencies that people hear best. The EPA recommends the use of an "A-weighted" scale for noise measurement when analyzing community noise impact levels. *Figure 3-37, Typical Range of Common Sounds*, shows the range of noise levels expressed as "A-weighted decibels" (dBA) that are produced by various sources. A quiet whisper produces about 30 dBA of sound, while a chain saw can produce over 110 dBA of sound.

BACKGROUND NOISE LEVELS

Existing background noise levels at the site are probably affected by the following sources: natural background sounds from wind, rain, and flowing streams; overflights by commuter aircraft traveling between Juneau, Sitka, and Haines; marine traffic along Lynn Canal; and the current exploration operations at the Kensington site.

Background noise measurements taken by the Forest Service at the proposed Quartz Hill mine site near Ketchikan, which is geographically similar to the Kensington site, ranged from about 32 dBA at an inland lake to 42 dBA along the shoreline (USDA Forest Service, 1988). The Forest Service recommends the following assumed background values for use in predictive noise modeling (USDA Forest Service, 1980).

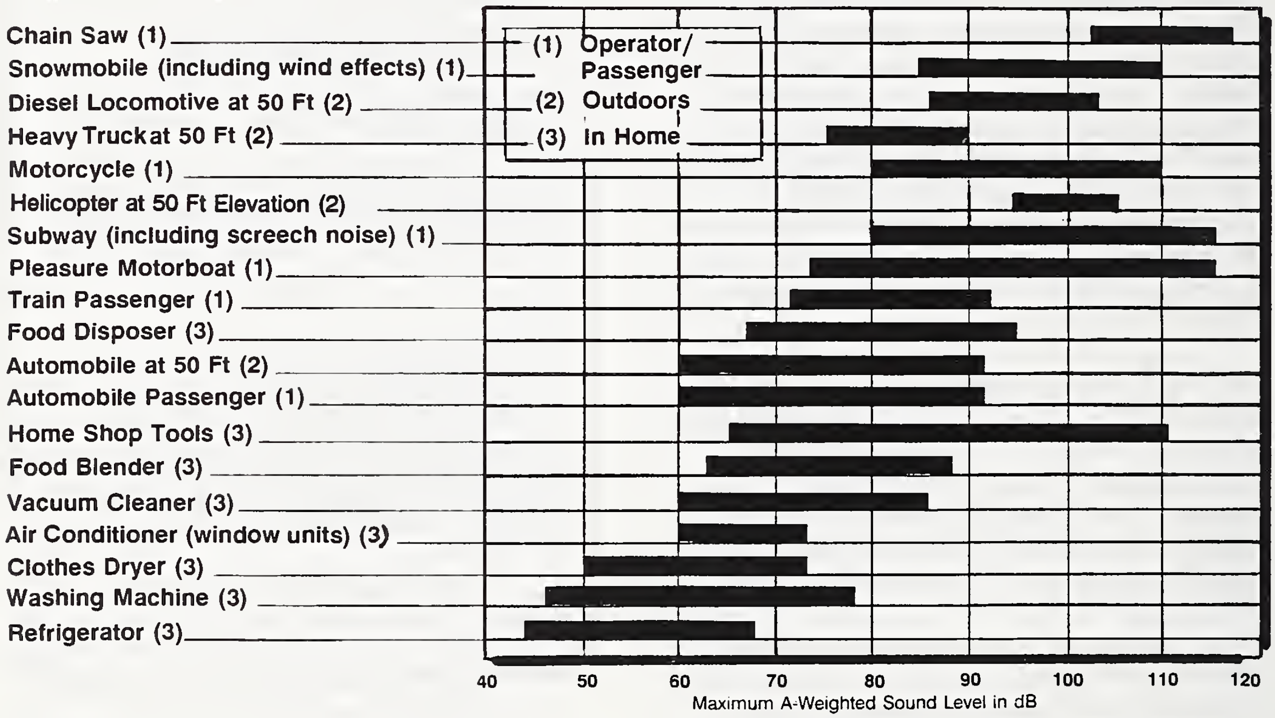


Figure 3-37, Typical Range of Common Sounds

By the logarithmic decibel scale, a doubling of the sound intensity corresponds to an increase of 3 dBA. A noise level increase of less than 1 dBA is barely detectable.

- Coniferous forest and no wind, 30 dBA
- Coniferous forest and moderate winds, 45 dBA
- Shoreline, calm sea and surf, 45 dBA
- Loud waterfall, 60 dBA

PERMISSIBLE NOISE LEVELS

Regulatory Noise Limits

The State of Alaska has no regulations limiting environmental noise impacts. Worker exposure noise limits for sources originating from the mining and ore processing operations are regulated by the Mine Safety and Health Administration (MSHA). The allowable MSHA noise limits are as follows.

- 8-hr exposure, 90 dBA
- 2-hr exposure, 100 dBA
- 15-minute exposure, 115 dBA

Guideline Limits for Recreational Areas

The Forest Service recommends that recreational area noise impacts caused by new facilities should be limited based on the recreational classification of the affected area (USDA Forest Service, 1980). Noise impact guidelines have been developed by the Forest Service. (*See Table 3-36, Recommended Maximum Noise Impacts in Recreational Areas*). It is not intended that these values be interpreted as strict numerical limits. Instead, the potential noise impacts in recreational areas are intended to be assessed on a case by case basis, accounting for factors such as the noise duration and the time of day when the noise will occur.

Table 3-36, Recommended Maximum Noise Impacts in Recreational Areas

Recreational Site Classification	Recommended Allowable Noise Impact in dBA[1]
Primitive Area	1
Semi-Primitive Areas	
Trail Camps Undeveloped Roadside Camps	5 10
Semi-Modern Areas	
Roadside Campgrounds Highly Developed Campgrounds	20 40

[1]Recommended impact noise levels are for Forest Service designated important receptor points within a given area.

CHAPTER FOUR

ENVIRONMENTAL CONSEQUENCES

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INTRODUCTION

This chapter of the FEIS provides the analytical basis for comparison of project alternatives (Chapter 2) with the existing environmental resources (Chapter 3). It discusses the anticipated environmental effects associated with implementation of the action alternatives in comparison to the No Action Alternative. This comparison of effects will be used to choose a preferred alternative. Although the comparison in this chapter is based on complete alternatives, the selected alternative may be a combination of options from each of the alternatives.

The project descriptions contained in Chapter 2 include mitigation measures which were developed to limit the occurrence or severity of environmental impacts. The environmental analyses presented in this chapter assumes that these measures would be implemented and that other features of the project would be completed as described.

For ease of presentation and comparison, the impact analysis discussions are grouped by the same technical disciplines discussed in Chapter 3. Although the anticipated environmental effects of alternatives were analyzed for each resource discipline, impact analyses emphasize those disciplines that relate specifically to the key issues and concerns identified in Chapter 1. Each action alternative would have some effect on existing land and resource conditions described in Chapter 3.

Under the No Action Alternative, the Forest Service would not grant the required permits, and approval for the operation would be denied. In this situation, existing exploration activities could continue, and the existing disturbance of about 15 acres would remain until exploration activities are terminated. However, it is unlikely that additional exploration would occur at the project site, since there would be no economic incentive for the Applicant to continue exploration, baseline and operational monitoring, or any other mining-related activities. It is expected that the Kensington Venture would cease all activities except caretaking at the site. After the mandatory prescribed time frame, the Kensington Venture would implement reclamation/closure activities according to the Plan of Operations approved for exploration.

Impact descriptions under each resource area are divided into the following categories;

- Effects of the No Action Alternative
- Effects Common to all Action Alternatives
- Effects of Each Action Alternative
- Cumulative Effects

Cumulative effects are the effects which result "from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions..." (40 CFR 1508.7). This EIS considered a wide range of proposed mining projects in Alaska and nearby British Columbia (See DEIS Appendix B). Other non-mining related projects, such as proposals to construct a surface road out of Juneau, were also considered. It was determined that only the proposed AJ project met the definition of being reasonably foreseeable. However, for some resource areas Jualin project impacts were also considered.

AIR QUALITY

This section discusses the expected impacts of the six project alternatives on air quality, climate, and visibility. Air pollutant sources and activities associated with each alternative are explained, and the expected emission rate of air pollutants is quantified. The environmental impacts caused by each alternative are compared.

EFFECTS OF THE NO ACTION ALTERNATIVE

Under this alternative no air pollutants from mining and/or milling would be emitted. If the permit application were denied, pollutant emissions associated with exploration activities could continue. Emissions from these activities would be negligible (TRC, 1991). (*See Air Quality, Chapter 3*).

EFFECTS COMMON TO ALL ACTION ALTERNATIVES

Potential air quality impacts include increases in airborne pollutant concentrations and visibility impairment. Visibility impacts would be localized (confined to an area within a few kilometers of the project) and would occur only during very stable periods of poor atmospheric dispersion. Computer modeling (using EPA ISC, COMPLEX I, and VISCREEN models) shows that visibility impacts at long distances from the project site, and at the nearest Prevention of Significant Deterioration (PSD) Class I area (Denali National Park), would be far below perceptible levels (TRC, 1991). Visibility impacts at Glacier Bay National Monument, west of the Kensington site, would also be imperceptible.

The magnitude of annual average emission rates of air pollutants gives an indication of the air quality impact of a facility. All things being equal, the greater the emissions, the larger the impact that a facility would have on the environment. Other factors also influence air quality impacts. The configuration of a pollutant source influences its air quality impact. Prevailing winds and terrain also determine the magnitude of airborne concentrations to a large degree. Finally, the distance from a pollutant source to the nearest point of public access affects the concentrations to which the public is exposed. EPA and ADEC policy requires that Alaska ambient air standards and PSD increments be met at the property boundary. Points of public access are typically used to define property boundaries.

As a frame of reference, the NO_x (Oxides of Nitrogen) emissions rate expected from the Kensington Project are about equal to a single cruise ship during its "hoteling" mode. The SO_2 (Sulfur Dioxide) emissions would be 50 times smaller than a cruise ship, and the particulate (dust) emissions would be one-third those of a cruise ship. The characteristics of the dust from the Kensington Project would be different than those associated with cruise ships. The gas turbines at Kensington would burn LPG, rather than low grade fuel oil, thus, there would be very little of the particulate "soot" that is often emitted from the cruise ships.

Construction Activity

Construction related pollutant emissions during the pre-production phase of all of the action alternatives (Alternatives B, C, D, E, and F) would not exceed 9 tons of particulates per year (TRC, 1990). Under each alternative the total surface area disturbance subject to wind erosion emissions would be about 50 acres, and the exposure time would be less than 1 year. Once grading is completed, foundations would be poured and exposed areas would be stabilized.

Diesel generators would be used as a temporary power supply during the construction phase of the operation. The installed capacity would be approximately the same as the LPG turbines needed for full project operation. Modeling indicates that NO_x emissions could exceed 250 tons per year which would trigger a PSD review if the installation were a permanent, stationary source. Modeling indicates that National Ambient Air Quality Standards would not be exceeded in the area around the project boundary (Richins, 1991). Applicable PSD increments would not be exceeded as shown on *Table 4-1, Construction Phase Pollutant Concentrations Model Results.*

Slash burning during the construction phase would cause smoke emissions. The burning would be limited to the construction months and would be confined to small, controlled areas to ensure fire safety. Slash burning would have to comply with open burning regulations imposed by the ADEC.

Production Activity

Pollutant emissions during the operational phase of the Kensington Project would be greater than during construction. During operation, primary pollutant emission sources common to all of the action alternatives would include the following.

- Exhaust Portal (emissions from underground operations)
- Access Road (vehicle emissions and dust)
- Haul Road (haul truck emissions and dust)
- Tailings Structure (dust from wind erosion)
- Powerplant (LPG-fired turbine generators)

Table 4-1, Construction Phase Pollutant Concentrations Model Results

Pollutant	Time Period	Modeled Concentration (ug/m^3)	PSD Increment[1] (ug/m^3)
NO_2	Annual	11.8	25
So_2	Annual	1.1	20
So_2	3-Hour	141.4	512
So_2	24-Hour	22.5	91

[1]Class 2 attainment increment.

Pollutant emissions from the ore processing facilities is not considered by this analysis. Since ore processing would be completely enclosed and primarily a wet operation, pollutant emissions would be negligible compared to the primary sources.

The following analysis presents the anticipated air quality impacts of each alternative. Additional factors, such as proximity of public access, source configuration, or meteorology that affect the expected ambient pollutant concentrations also are discussed. Pollutant emission rates were computed using standard EPA and other accepted emission factors and equations (TRC, 1990). Total Suspended Particulates (TSP) emissions from the tailings facilities were calculated from the structures at maximum size.

EFFECTS OF ALTERNATIVE B

Under Alternative B, the production facilities at the project would consist of an underground mine and primary crusher, a mill and processing facilities located at the surface, and an impoundment for tailings disposal. The ancillary/support facilities would include a permanent employee camp for 250 production employees, a LPG-fired gas turbine powerplant, a marine terminal near Comet Beach for receiving equipment, supplies and fuel, fuel storage tanks, offices, shops, warehouses, sewage disposal facilities, and a solid waste incinerator.

A complete emissions inventory has been calculated for emissions sources in Alternative B (TRC, 1991) and is shown in *Table 4-2, Complete Pollutant Emission Rates, Alternatives B and F*. This inventory was included by the Kensington Venture in an Air Quality Permit To Operate Application to the ADEC.

As indicated, the primary pollutant emission sources would include the underground mine exhaust portal, the unpaved access road, the waste rock haul road, the tailings impoundment, and the power plant. For comparative purposes, the pollutant emissions from these primary sources are summarized in *Table 4-3, Pollutant Emission Rates - Alternatives B and F*.

The 250 tons per year threshold for the PSD applicability is not exceeded for any of the pollutants. The maximum heat input rate for all three turbines is 173 million Btu per hour, below the 250 million Btu per hour threshold for PSD applicability, and the turbines do not generate electricity by steam. From the above information it is clear that the Kensington Project would not be subject to PSD review.

The expected ambient air quality impact of Alternative B was calculated with EPA's COMPLEX I and Industrial Source Complex (ISC) models. Air quality impacts were calculated to be well below allowable federal and Alaska ambient air quality standards, as shown in *Table 4-4, Comparison of Modeled Concentrations with Ambient Air Quality Standards*. Maximum predicted NO_2 and SO_2 concentration contributions from Alternative B are compared to PSD Class II increments in *Table 4-5, Comparison of Modeled Concentrations with PSD Class II Increments*.

Air quality dispersion modeling (TRC, 1991; Table 6.2) indicates that the maximum annual and 24-hour modeled TSP concentrations outside the Kensington property boundary are 3.23 ug/m^3 and 17.71 ug/m^3, respectively.

Table 4-2, Complete Pollutant Emission Rates, Alternatives B and F

Source (Description)	Annual Emissions (tons/year)					Daily Maximum Emissions (lb/hr)				
	NOx	SO_2	CO	TSP	HC	NOx	SO^2	CO	TSP	HC
Exhaust Portal	69.99	11.30	60.26	6.10	5.35	19.28	3.11	16.53	1.72	1.47
Coarse Ore Storage	--	--	--	0.002	--	--	--	--	0.01	--
Mill	--	--	--	0.10	--	--	--	--	0.03	--
Access Road	0.67	0.06	0.28	10.83	0.06	0.23	0.02	0.10	7.30	0.02
Haul Road	0.22	0.07	0.07	5.15	0.02	0.06	0.02	0.02	2.61	0.01
Waste Rock/Dam	4.91	0.47	1.51	8.98	0.54	1.35	0.13	0.41	3.43	0.15
Tailings	--	--	--	1.22	--	--	--	--	10.64	--
Power Plant	136.50	0.10	46.00	11.21	5.70	31.17	0.03	10.50	2.56	1.30
Incinerator	0.09	0.11	0.91	0.68	0.68	0.08	0.10	0.83	0.63	0.63
Refinery	2.13	0.002	0.53	0.08	0.04	0.58	NEG	0.15	0.02	0.01
Fuel Storage	--	--	--	--	0.34	--	--	--	--	0.08
Helicopters	0.55	0.08	2.47	0.73	1.24	0.13	0.02	0.56	0.02	0.28
Tugboats	0.42	0.08	0.19	0.53	0.07	0.67	0.13	0.30	0.12	0.09

Table 4-3, Pollutant Emission Rates - Alternatives B and F (tons per year)

Source	Oxides of Nitrogen (NO_x)	Sulfur Dioxide (SO_2)	Carbon Monoxide (CO)	Total Suspended Particulates
Exhaust Portal	69.99	11.30	60.26	6.10
Access Road	0.67	0.06	0.28	10.83
Haul Road	0.22	0.07	0.07	5.15
Tailings	----	----	----	1.22
Power Plant	136.50	0.10	46.00	11.21
Miscellaneous	8.10	0.75	5.61	11.10
TOTAL	215.48	12.28	112.22	45.61

Table 4-4, Comparison of Modeled Concentrations with Ambient Air Quality Standards (including background)

Pollutant	Averaging Time	Max Predicted Concentration (ug/m³)	Federal Standard (ug/m³)	Alaska Standard (ug/m³)
NO_2	Annual	12.4	100	100
CO[1]	8-Hour 1-Hour	394.8 2,544.2	10,000 40,000	10,000 40,000
Partic[2]	Annual 24-Hour	25.2 57.7	50 150	50 150
SO_2	3-Hour 24-Hour Annual	156.8 24.5 1.5	1,300 365 80	1,300 365 80

[1]Predicted CO concentrations do not include background.
[2]Federal particulate standard expressed as PM-10; Alaska standard expressed as PM-10.

Table 4-5, Comparison of Modeled Concentrations with PSD Class II Increments

Pollutant	Averaging Time	Max Predicted Concentration (ug/m³)	PSD Increment (ug/m³)
NO_2	Annual	8.36	25
SO_2	3-Hour 24-Hour Annual	156.8 24.5 1.5	512 91 20

These concentrations are well below the Class II PSD increments for TSP (19 ug/m³ annual and 37 ug/m³ 24-hour).

EFFECTS OF ALTERNATIVE C

The components unique to this alternative are: 1) construction of 8.5 miles of unpaved road connecting Slate Creek Cove in Berners Bay to the mine/mill site; 2) a daily commute of workers by ferry from Auke Bay to the Slate Creek Cove terminal and then transport to the mine site by bus; 3) no use of a permanent employee camp onsite; and 4) transport of supplies and equipment to the mine/mill over the 8.5 mile road from Slate Creek Cove.

Pollutant emissions associated with construction of the Berners Bay access road would be highly localized and of short duration.

Total suspended particulate (TSP) emissions on the 8.5 mile access road would be higher than those on the shorter access roads in the other action alternatives. This is directly related to the longer travel distance of the Berners Bay access road, consequently, more pollutants would be emitted. Total pollutant emission rates for Alternative C are shown in *Table 4-6, Pollutant Emission Rates - Alternative C.*

In addition to the particulate emissions caused by the 8.5 mile Berners Bay access road, the impact of ferry boat emissions in Berners Bay have been evaluated. It is possible that the ferries used to transport employees to and from the Slate Creek Cove terminal would remain at Berners Bay for some time during the work day. Pollutant emissions from ferry boat "hoteling" mode would not exceed ambient air standards or PSD increments, but emissions could contribute to visibility impairment during episodes of limited atmospheric dispersion.

Table 4-6, Pollutant Emission Rates - Alternative C (tons per year)

Source	Oxides of Nitrogen	Sulfur Dioxide	Carbon Monoxide	Total Suspended Particulates
Exhaust Portal	69.99	11.30	60.26	6.10
Access Road	2.28	0.20	0.95	52.80
Haul Road	0.22	0.07	0.07	5.15
Tailings	----	----	----	1.22
Power Plant	136.50	0.10	46.00	11.21
Miscellaneous	8.04	0.67	5.00	10.64
TOTAL	217.03	12.34	112.28	89.12

EFFECTS OF ALTERNATIVE D

The component unique to Alternative D is the conventional (wet) tailings impoundment in the Sweeny Creek drainage. A 2-mile haul road would be constructed from the lower portal to the dam site for the transport of waste rock for use in embankment construction. In addition, the LPG turbine generators would not be located near the process area (as in the other action alternatives) but closer to Comet Beach, approximately 500 feet east of the main heliport. Total pollutant emission rates are shown in *Table 4-7, Pollutant Emission Rates - Alternative D*.

The location of the tailings impoundment at Sweeny Creek would be closer to the Kensington Venture claims boundary than would the Sherman Creek location.

Because of the proximity of the Sweeny Creek tailings to the claims boundary, additional fugitive dust emission controls might be required to comply with ambient air quality standards or increments at the claims boundary near the Sweeny Creek tailings impoundment. The dust emissions from the waste rock haul and from the tailings impoundment would cause larger ambient air pollutant concentrations along

Table 4-7, Pollutant Emission Rates - Alternative D (tons per year)

Source	Oxides of Nitrogen	Sulfur Dioxide	Carbon Monoxide	Total Suspended Particulates
Exhaust Portal	69.99	11.30	60.26	6.10
Access Road	0.67	0.06	0.28	10.83
Haul Road	0.44	0.14	0.14	10.30
Tailings	----	----	----	1.08
Power Plant	136.50	0.10	46.00	11.21
Miscellaneous	8.10	0.75	5.61	11.10
TOTAL	215.71	12.35	112.29	50.62

the claims boundary than would the Sherman Creek location.

Maximum pollutant concentrations from hot stack emission sources, such as the gas turbines, occur when the emission plume impacts terrain close to the source. This terrain impact prompts large concentrations because the emissions would have had little time to disperse in the atmosphere before striking the ground. Assuming identical pollutant emission rates whether the turbines are situated near Comet Beach or at the process area, proximity of elevated terrain Is the major influence in inducing large ambient ground level concentrations.

With the gas turbines located near Comet Beach, it would be expected that maximum modeled air pollutant concentrations at areas outside the project boundary would be equal to, or smaller than, those associated with the proposed gas turbine location at the process area (Alternatives B, C, E, and F). This is because the emission plume from turbines near Comet Beach would travel further before striking high terrain.

EFFECTS OF ALTERNATIVE E

Alternative E incorporates a dewatered (dry) tailings disposal site instead of a conventional (wet) tailings impoundment. Tailings would be dewatered using mechanical and thermal methods. The dried tailings would then be transported by truck to the tailings disposal site.

Pollutant emissions associated with handling of dewatered tailings would occur from the haul truck traffic moving approximately 4,000 tons per day of dewatered tailings over 0.3 mile (Site A) or 1.0 mile (Site B) of unpaved road to the tailings impoundment; from wind erosion of the dewatered tailings area of 165 to 170 acres; and from an increase in power consumption and generating needs for thermal drying of tailings prior to disposal.

The pollutant emissions associated with these three extra sources were computed by TRC (1990), and total pollutant emission rates for the Alternative E are shown in *Table 4-8, Pollutant Emission Rates - Alternative E.*

The potential TSP pollutant emissions from Alternative E would be three to six and a half times larger than those from the other action alternatives. The increase in emissions would come primarily from the dewatered tailings structure. Emissions from dewatered tailings were computed using the minimum wind erosion rate of dewatered tailings given by the EPA (EPA, 1976) as 1.3 tons/acre/year (TRC, 1990). This factor corresponds to areas with the most favorable climatic factors (high precipitation and low evaporation). The tailings

Table 4-8, Pollutant Emission Rates - Alternative E (tons per year)

Source	Oxides of Nitrogen	Sulfur Dioxide	Carbon Monoxide	Total Suspended Particulates
Exhaust Portal	69.99	11.30	60.26	6.10
Access Road	0.67	0.06	0.28	10.83
Haul Road	0.22	0.07	0.07	5.15
Tailings[1]	----	----	----	221.00
Tailings Haul	----	----	----	23.51
Power Plant	146.06	0.11	49.22	11.99
Miscellaneous	8.10	0.75	5.61	11.10
TOTAL	225.04	12.29	115.44	294.32

[1]TSP emissions given for Site A (170 acres).

emissions would occur near ground level and from a reasonably small area. Particulate matter emissions in excess of ambient air quality standards outside the public access boundary might occur. During dry periods, water spray would be used to control and reduce particulate emissions from the dewatered tailings pile.

Thermal drying of the tailings would be necessary for stability and trafficability of the dewatered tailings structure *(See Alternative E, Chapter 2)*. The dryer would emit 120 tons of water vapor per day. The vapor would condense shortly after release to form a steam plume during most periods except the warmer summer months. Because of the predominance of high humidity and cool temperatures in southeast Alaska, this steam plume often would be visible for long distances before dissipating downwind.

EFFECTS OF ALTERNATIVE F

Alternative F would have the same effects as Alternative B.

CUMULATIVE EFFECTS

Cumulative air quality impacts would occur if air pollutant emissions from the project were to cause pollutant concentration increases at locations impacted by other projects. That is, cumulative effects occur where there is an overlap of air quality impacts.

The distribution of air pollutant concentration increases from the Kensington Project would be very localized and confined to the near vicinity of the site. Annual average NO_x concentrations would decrease to levels below detectable limits within about 1 kilometer (0.6 mile) of the mill site. Similarly, TSP and SO_2 concentrations fall off rapidly with downwind distance, to the extent that both annual average TSP and SO_2 modeled concentrations are less than 1 ug/m^3 within about 500 meters (1,640 feet) of the project boundary (TRC, 1991). Consequently, the air quality cumulative impact of the Kensington Project and other proposed or suggested projects would be extremely small.

The expected cumulative air quality impact of the Kensington Project at the AJ or Greens Creek Projects, both located about 45 miles southeast of Kensington, would be immeasurably small. Air quality impacts from the Kensington Project at the Jualin site, located 2.5 miles southeast from Kensington (and in a different airshed) would be below detectable levels, and certainly below applicable ambient air standards.

SUMMARY

The air quality impact of the five action alternatives can be compared by examining the expected pollutant emissions from each. Emission rates for Alternative B were the only rates modeled for comparison to ambient air quality standards. However, the emission rates of NO_x, SO_2, and CO (carbon monoxide) are nearly identical for all of the action alternatives (Alternatives B, C, D, E, and F), and modeling of emission rates for these pollutants for Alternatives C, D, E, and F would be expected to produce similar results. Projected TSP emission rates differ considerably between action alternatives. (*See Table 4-9, Comparison of Total TSP Emissions*).

Table 4-9, Comparison of Total TSP Emission

Project Alternative	TSP Emissions (tons per year)
No Action	negligible
Alternative B and F	45.61
Alternative C	89.12
Alternative D	50.62
Alternative E	294.32

The particulate emissions from Alternatives B, D, and F are similar, while emissions from Alternative C would be about double those of Alternatives B, D, and F. TSP emissions from Alternative E would be about triple that of Alternative C.

Alternative C (Berners Bay Access) particulate emissions are caused by the added 8.5 mile access road from Berners Bay to the site. Dust emission increases from the unpaved road and exhaust emissions associated with ferry transport to Slate Creek Cove would be expected.

The proximity of the tailings Impoundment in Alternative D to the project claims boundary would result In the highest particulate concentrations at areas of public access.

Alternative E (Dewatered Tailings) would have the highest particulate emissions due primarily to the higher wind erosion emissions from the dewatered tailings storage.

In order to receive permits to construct any of the action alternatives, the project must comply with the Alaska State Implementation Plan and the ADEC air quality regulations. These regulations require an applicant to demonstrate that pollutant emissions would meet ambient air quality standards and, where applicable, PSD increments, before construction could begin. None of the proposed alternatives would be subject to PSD regulations based on their predicted emission rates.

GEOTECHNICAL CONSIDERATIONS

This section discusses earthquakes, landslides, avalanches, and other geotechnical aspects that could potentially affect project development.

EFFECTS COMMON TO ALL ACTION ALTERNATIVES

Seismic (earthquake) impacts are common to all action alternatives. Earthquake magnitudes generated on large fault systems (Fairweather and Chatham) and associated strong ground accelerations are discussed in detail under the No Action Alternative. Pronounced lineaments potentially associated with fault activity are common to all action alternatives.Earthquake damage to embankments can arise from two sources:

1) Actual ground rupture beneath the embankment; and
2) Seismic shaking.

With regard to ground-rupture, Geomatrix (1988), has completed a lineament analysis to identify potential surface rupturing in the vicinity of the Kensington project. According to Geomatrix (1988), existing geologic maps identified two fault zones within the project area. These involve the Gastineau Channel Fault, which is mapped traversing Sweeny Creek and the Independence Lake-Johnson Creek Fault. The Gastineau Channel Fault is mapped along the Gastineau Channel near Juneau, and is mapped as continuing northward along a topographic low expressed as a lineament by Slate and Sweeny creeks in the project area. A photogeologic analysis and geologic literature review completed by Geomatrix (1988) revealed no evidence of Holocene or recent activity along the Gastineau Channel Fault.

Non-earthquake related geotechnical consequences are generally common to all action alternatives. These include landslides, avalanches, and mass wasting. Generally these consequences are more likely to occur in areas where the terrain exceeds 30 percent in slope. Other seismic risks include the following.

- Settlement of cohesionless soils - This must be considered in the design of structural foundations (piles) placed in Slate Creek Cove under Alternative C.
- Soil liquefaction - This must be considered in the design of structural foundations (piles) placed in Slate Creek Cove (Alternative C), and saturated tailings material placed in a wet tailings facility (Alternatives B, C, D, and F).
- Tsunamis or seiche effect - While this effect seems unlikely due to the protected nature of the Kensington Project, earthquakes generated on the Fairweather or Chatham Strait fault may result in tsunamis run-up conditions and/or seiches in water retention containment basins.

Properly situated mine structures and engineered foundations would minimize seismically induced risks at the site.

Other Geotechnical Considerations

Slope stability conditions have the potential to affect facilities (pipelines, roads, transmission lines, etc.) situated in steep areas containing unstable soils or bedrock with unfavorable dip directions. Based on the steep, northerly dipping and east-west striking regional bedrock

units, slope instability in the bedrock is most likely to occur on north-facing slopes. A debris slide and slope stability hazard analysis completed for the Kensington Project (Alaska Earth Sciences, 1990) indicates the slope conditions in the vicinity of the mill and portal are relatively stable despite the steep slope conditions. Landslide risks can be reduced by avoiding steep slopes, minimizing undercuts of existing slopes, maintaining soil or vegetative cover, and reducing surface water infiltration.

Minor rock falls could also pose a potential rupture hazard for pipelines in areas where slope stability is in question. Potential rock fall hazards would need to be assessed on a case by case basis for each pipeline corridor considered for a particular development alternative. In areas where pipeline construction cannot avoid potential rock fall areas, the pipeline would be armored or protected in some similar manner to minimize the potential for rupture and accidental spills.

Avalanche hazards exist north of the proposed Sherman Creek tailings site. The precise location of these hazards can be identified by completing avalanche runout zone mapping. Avalanche hazard mitigation can be accomplished by maintaining tree cover, designing deflection structures, and avoidance.

Surface blasting associated with quarry and borrow source development could result in minor ground tremors, flyrock, and noise. However, blasts would be carefully controlled through a blasting plan which would be developed by the Applicant as a part of the operations plan. This plan would maintain ground tremors below destructive limits and minimize flyrock and noise levels.

Worst Case Analysis - Dam Failure

The tailings impoundment proposed for the Kensington Project is designed to withstand the Maximum Credible Earthquake (MCE) expected for southeast Alaska. The MCE is defined as the maximum earthquake that appears capable of occurring under presently known tectonic framework. An earthquake event of this size which occurred in the vicinity of the Kensington Project would result in massive destruction in southeast Alaska and would severely impact Juneau, Haines and the smaller communities in the area.

The tailings dam would be constructed from compacted earth and rockfill materials which are considered desirable materials for design of retention structures in seismic areas.

Construction would be by modified centerline method. The centerline raising method is a compromise between the upstream and downstream methods of construction. As a result, it shares to a degree, the respective advantages of the two methods, while mitigating their disadvantages. For centerline construction, initially, a starter dike is constructed and tailings are peripherally spigoted from the dike crest to form a beach. The subsequent raises are constructed by placing fill onto the beach and onto the downstream slope of the previous raise. The centerline of the raises are coincident as embankment progresses upward, given rise to the name. The susceptibility of upstream embankments to liquefaction under severe seismic ground motion is well documented. Centerline construction has proven to be an effective means of tailings management in highly seismic areas.

The volume of fill required for a given embankment height is intermediate between that for upstream and downstream methods. Experience has shown a centerline design technique to be seismically stable under high seismic loads. Moreover, all seismic flow failures reported to date have occurred for upstream type tailing dams subjected to strong seismic shaking (S. Vick, 1990). Experience from over 20 inactive upstream tailings dams abandoned over periods ranging from several years to 30 years and subjected to strong seismic shaking, often in excess of M.7.0 with an epicentral distance as close as 15 kilometers, shows that no inactive tailings dam ever failed, even though manifestations of high pore pressures such as sand boils were commonly reported (S. Vick, 1990).

Given the unlikelihood of a seismic induced dam failure, an alternate dam failure scenario was developed to describe a worst case event. The analysis displays the consequences of failure of the tailings dam at its maximum water

holding phase. The effects described in this section are **not** expected to occur under any of the alternatives. Dam design, construction, and operation procedures would be implemented to prevent this from happening. However, recent history shows a dam failure rate of 0.3 percent. (ASCE/ICOLD, 1975)

The worst case failure is developed as an over-topping or piping type failure. The scenario assumes that a probable maximum flood event has deposited 630 acre-feet of water in the impoundment. This volume of water is entirely discharged through a failure in the embankment.

The escaping water cuts through the embankment, taking with it embankment material and tailings. Flow starts slowly at first and quickly builds to a peak of 17,000 cfs. From the peak, volume quickly falls off. The entire event is over in about 27 minutes. About 215,000 tons of solids are transported from the tailings and the embankment.

Most of the tailings would be deposited in Lynn Canal. Some material, most notably the coarser embankment material, would be deposited along sections of the Sherman or Sweeny creek channels depending on the dam location. Most sections of affected stream channels and adjacent low-lying areas would be scoured by the flood.

The embankment design proposed for the Kensington Project incorporates centerline construction techniques. Experience has shown centerline constructed dams to be stable under high seismic loads. Moreover, all seismic flow failures reported to date have occurred only for upstream type tailings dams subjected to strong seismic shaking (Vick, 1990).

Worst Case Analysis - Dewatered Tailings Structure Failure

Preliminary stability studies (Golder, 1989) for dewatered tailings assume embankment slopes of 2:1 (27 degrees). Assuming low moisture conditions in the tailings and loose silty sand or inorganic silt, representative values of internal friction are approximately 27 to 33 degrees (Terzaghi and Peck, 1948). Based on the above parameters, downslope movement of dewatered tailings at Site A or B is unlikely even under strong seismic loads, and a worst case failure would have no significant downslope impact.

EFFECTS OF ALTERNATIVE B

Landslide impacts in the areas developed under Alternative B would be minimal. Slopes in the project area vary from level to nearly vertical, however, the majority of the areas where mine facilities would be located are in low susceptibility (less than 30 percent) regions. (See *Figure 4-1, Slope Susceptibility Map - Alternative B and F*). Relatively gentle slopes are found in the lower staging area which includes the explosives storage, marine terminal, LPG storage/laydown area, fuel transfer facility, and heliport. The access road parallels the break in slope and is situated in areas which are classified as low hazard. High hazard conditions (greater than 30 percent

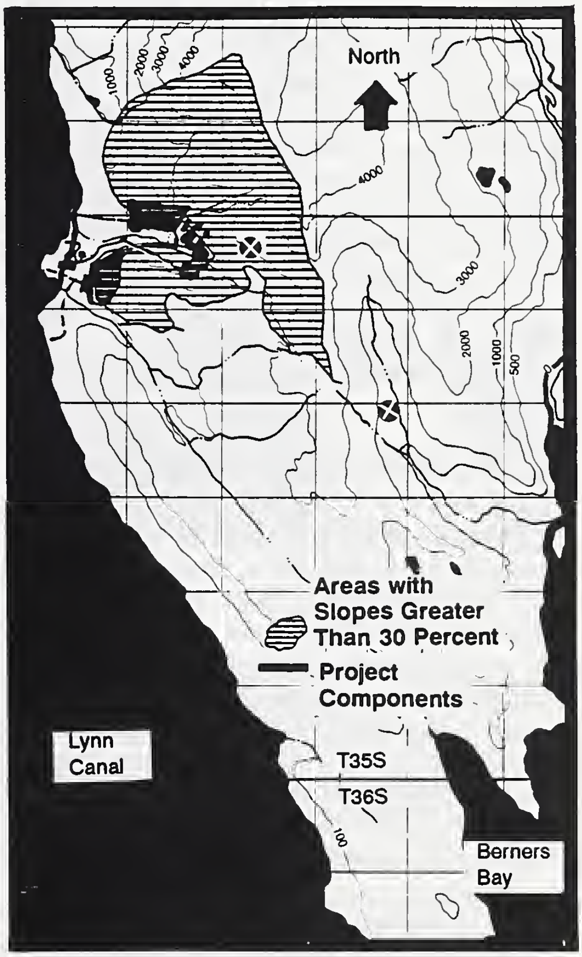

Figure 4-1, Slope Susceptibility Map - Alternative B and F

slopes) characterize the area immediately south of the portal and east of the tailings facility (Lions Head Mountain).

Landslide hazards that may affect Alternative B are expected to be most severe during the construction phase. Potential landslide hazards would be restricted to the mine access road which parallels the break in slope. Excavation, filling, and blasting associated with widening of the access road may result in temporary unstable conditions and minor movements of surface material onto the road or directly downslope of the road. Slope failures during construction would require additional clearing and stabilization procedures depending on the extent of the failure.

Avalanches, or natural downslope movement of snow, is a function of many complex physical interactions encompassing terrain, vegetation, and climatic conditions. In portions of the project area these factors combine to produce nearly constant, moderate to high avalanche hazards at specific points within runout zones. The proposed Sherman Creek tailings site is unaffected by current avalanche runout zones. Similarly, the proposed mill site is void of avalanche threat under normal conditions; however, it may be affected at its northern fringe by rare major avalanche events caused by exceptional meteorological and snowpack conditions, especially if these occur in combination with seismic activity (Fessler, 1987).

A portion of the Ophir Creek diversion would occur near the bottom of an avalanche chute but outside of the historical slide zone. It is possible, but unlikely, that an avalanche could extend beyond the historical slide zone and block a portion of the Ophir Creek diversion. An avalanche of this magnitude would only occur following a heavy winter snowfall. During winter, flows in the diversion would be low, and any water breaching the diversion as a result of snow blockage would be contained within the Sherman Creek tailings impoundment until clearing and repairs were completed.

The Ophir Creek diversion would be sized to handle the probable maximum flood of 1,245 cfs. Even under high flow conditions, flow from Ophir Creek would not pose a potential threat to the Sherman Creek tailings impoundment by overtopping the dam.

The probable maximum flood (PMF) is defined as the largest flood that can reasonably be expected to occur on a given stream at a selected point. Determination of the PMF is based on consideration of the chances of simultaneous occurrence of the maximum of the several elements (humidity, temperature, dewpoint, wind, geography, soil moisture, etc.) or conditions which contribute to the flood. The return period for a PMF can not be defined statistically because of the simultaneous combination of extreme conditions for several elements that generate a storm event. For this reason PMF storms are used when designing a dam spillway or diversion structure.

Portions of the Sherman Creek tailings dam foundation overlie alluvial and terrace sands and gravels which extend up to and below mid-abutment level on the valley wall (Dames & Moore, 1990c). This material may represent potential ground water seepage paths. Drill hole SH-23 indicates this zone is approximately 31 feet thick. Several minor sand lenses have been identified in the vicinity of drill hole SH-14B (Knight and Piesold, Ltd., 1990). This material may liquefy under extreme earthquake loading (Knight and Piesold, Ltd., 1990) and, therefore, would require removal or consolidation prior to tailings dam construction.

The design of the tailings impoundment structure includes evaluation of embankment performance under dynamic conditions. Such analysis provides an estimate of potential impacts due to earthquakes. For the Kensington Project the design would include the development of peak horizontal ground accelerations and velocities based on the seismic history of the area. Knight and Piesold, Ltd. (1990) have determined the resultant ground motion for a 1 in 475 year return period (10 percent probability of exceedance in 50 years) are as follows:

- Peak horizontal ground acceleration 0.231 g
- Peak horizontal ground acceleration 0.353 m/sec.

Knight and Piesold has classified the tailings facility as having a low hazard using a

corresponding earthquake of magnitude 7.0 (Richter scale) which exceeds the largest earthquake within 130 miles of the project site over the past 20 years. Based on the above seismic criteria, the tailings embankment would be designed to withstand earthquakes and ground motions expected in the area.

Design calculations by Knight and Piesold (1990) show the following minimum factors of safety.

- Stage I; 1.45
- Stage I - Seismic Loading; 1.06
- Final Embankment; 1.5
- Final Embankment - Seismic Loading; 1.2
- Final Embankment - Liquefied Tailings; 1.4

The factor of safety designation has gained universal acceptance and is considered a convenient tool for engineers in evaluating embankment, slope, and foundation stability. The term represents an attempt to draw a strict line of demarcation between a state of incipient failure and a state of absolute safety. In soil and rock mechanics, the factor of safety is defined as the ratio of the total force resisting failure to the total deforming force attempting to produce failure. In most cases these forces would be shear forces and at critical equilibrium the factor of safety is unity (1). This implies that the resisting shear forces are just able to balance the deforming shear forces. As the factor of safety increases above unity, the concept of degree of safety is invoked. The degree of safety represents the extent to which the deforming forces would have to be increased with respect to the natural shear resistance of the geological material before failure would ensure.

Comparison of the Final Embankment factor of safety of 1.5 with the Final Embankment-Liquefied Tailings factor of safety of 1.4 emphasizes that strength of the tailings at closure has only a minor effect on embankment stability.

EFFECTS OF ALTERNATIVE C

The geotechnical impacts identified in Alternative B generally apply to Alternative C (*See Figure 4-2, Slope Susceptibility Map - Alternative C*). In addition, the access road and transmission line which extend north-south along Lynn Canal would be partially situated in wetland areas which may require specialized construction techniques to maintain grade and surface water drainage and avoid excessive settlements.

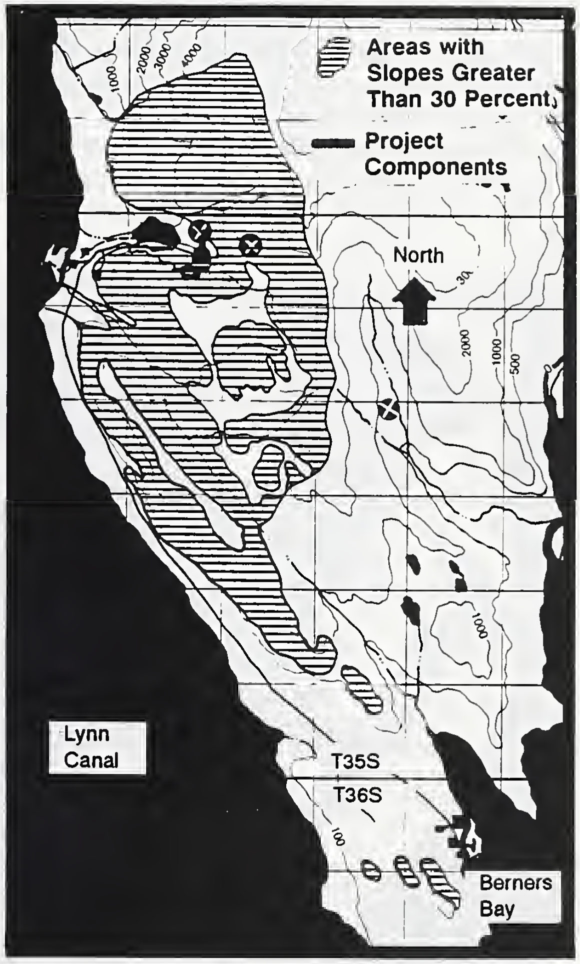

Figure 4-2, Slope Susceptibility Map - Alternative C

Offshore facilities located in Berners Bay, including the dock and possibly the marine terminal facility, may require the installation of deep piles to provide foundation support through soft, liquefiable silt deposited in Berners Bay.

Five additional borrow sites are identified in Alternative C. Each borrow site would require blasting to excavate. It is anticipated these quarries would provide adequate base course material for road construction. Acceptable

abrasion resistant road surfacing material may require importation from alternative borrow sources off site.

EFFECTS OF ALTERNATIVE D

Alternative D presents greater exposure to landsliding and avalanche impacts than the previous alternatives. The upper reservoir area of Sweeny Creek includes historic evidence of past mass movement. (*See Figure 4-3, Historic Avalanche and Landslide Areas*). Vegetation scars and hummocky terrain indicate this area has experienced landslide, avalanche, or debris-type flows in the past.

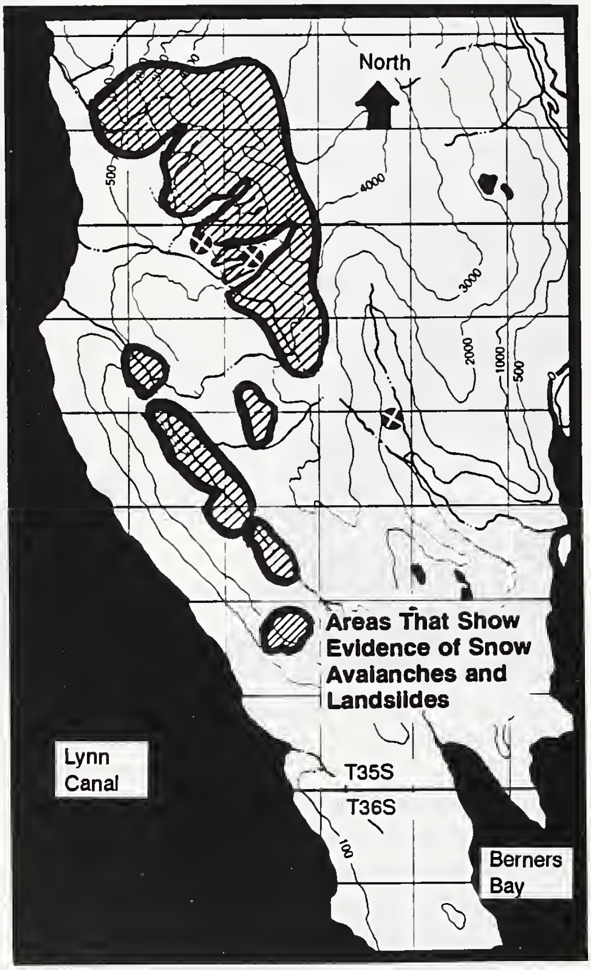

Figure 4-3, Historic Avalanche and Landslide Areas

The majority of the areas where the remaining mine facilities would be located are in low susceptibility (less than 30 percent slopes) regions. (*See Figure 4-4, Slope Susceptibility Map - Alternative D*). Relatively gentle slopes are found in the lower staging area which includes the explosives storage, marine terminal, LPG storage/laydown area, fuel transfer facility, and heliport. The access road to the mine facilities (excluding the tailings dam) parallels the break in slope and is situated in areas which are classified as low hazard. High hazard conditions (greater than 30 percent slopes) characterize the area immediately south of the portal and the tailings pipeline extending from the Sweeny Creek tailings area to the mill.

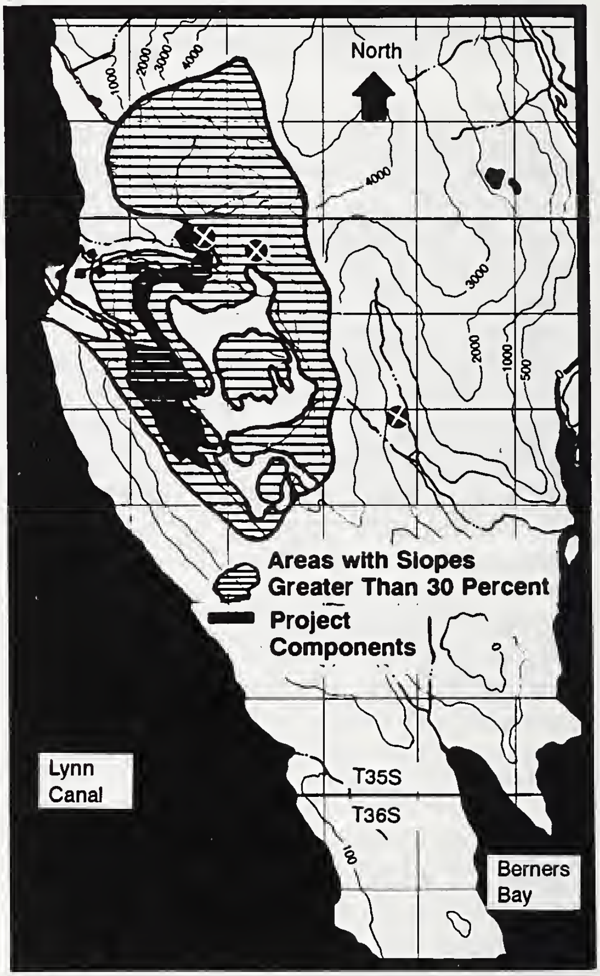

Figure 4-4, Slope Susceptibility Map - Alternative D

Landslide hazards that do exist as part of Alternative D are expected to be most severe during the construction phase. Landslide impacts would likely be restricted to the mine access road and tailings pipeline which parallel

the break in slope and are within the upper reaches of the Sweeny Creek reservoir. Excavation, filling, and blasting associated with widening of the access road may result in temporary unstable conditions.

Alternative D includes the siting of a permanent waste rock dump of about 612,000 tons in an area immediately downslope, but outside, of a large avalanche runout zone. It is envisioned that under a worst case scenario a large avalanche could extend past the existing runout zone and would impose additional loads on the waste dump. The impacts of such loads would be dependent on velocity, density, and volume of snow load. Under a worst case scenario, driving forces could exceed resisting forces resulting in failure of the waste dump. Downslope impacts, however, would be minimal as there exists no significant structures immediately down gradient of the waste dump. Based on the location of the waste rock dump, potential impacts to Sherman Creek are low even under worst case failure conditions.

As with Alternative B, the tailings impoundment and diversion structures would be sized to contain the PMF. Therefore, potential threats to dam stability from overtopping would be nonexistent.

EFFECTS OF ALTERNATIVE E

Based on preliminary site screening, two sites (*See Figure 2-8, Dewatered Tailings Disposal Site Options*) have been identified for potential construction of a dewatered tailings pile.

Site A is located between elevation 400 and 760 feet, Immediately north of Sherman Creek, below its confluence with Ophir Creek on the moderate valley slopes (approximately 15 percent) between the steep mountain side and Sherman Creek. Based on the foundation slope and a review of aerial photography, this site is classified as a low hazard area (*See Figure 4-5, Slope Susceptibility Map - Alternative E*) for landslides, mass movement, and avalanches. Drill hole, test pit, and seismic data completed over part of this area indicates the soils are comprised of alluvial and fluvial sands and gravels up to 30 feet thick overlying glacial till in excess of 175 feet thick (Knight and Piesold, Ltd. and SRK, 1991).

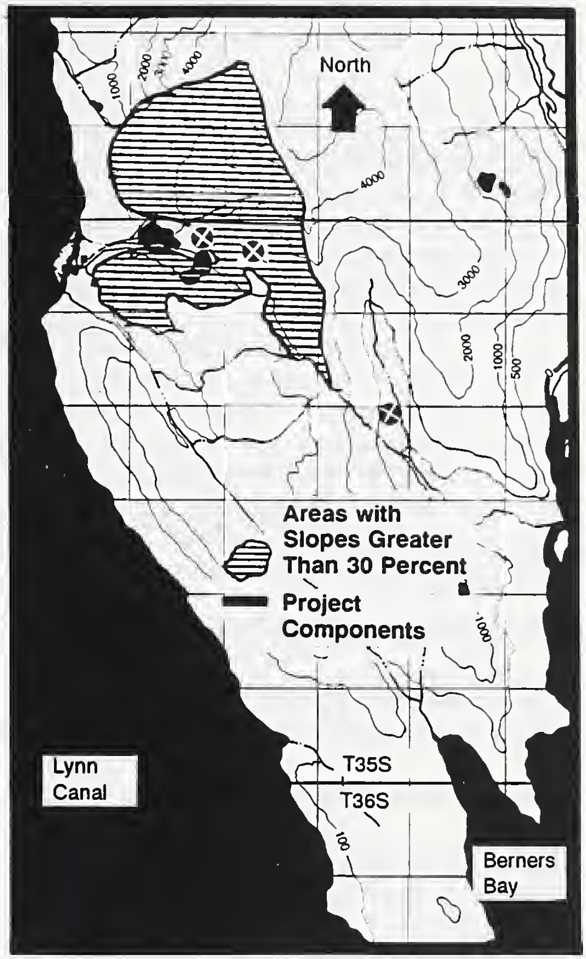

Figure 4-5, Slope Susceptibility Map - Alternative E

Site B is located between elevations 160 and 490 feet, slightly south of Sherman Creek on the terrace adjacent to Lynn Canal. The average slope of the foundation soils below the tailings pile is approximately 10 percent, and, therefore, is classified as a low hazard zone (*See Figure 4-5, Slope Susceptibility Map - Alternative E*) for landslides, mass movement, and avalanches. Site specific investigations were not completed in the Site B area; however, based on an extrapolation of the regional geology, the area is believed to be underlain by the same sequence of alluvial and fluvial sands and gravels, till, and bedrock that underlies Site A.

An analysis of the physical characteristics of the tailings based on recent metallurgical testing indicates the maximum moisture content that

the bulk tailings could have from the perspective of handleability and trafficability would be approximately 16 and 14 percent, respectively (Knight and Piesold, Ltd. and SRK, 1991).

A key stability requirement of the dewatered tailings in an unsupported pile is resistance to liquefaction under extreme earthquake loading. Physical testing on the tailings indicates the moisture content of the bulk tailings must not exceed 14 percent at the time of placement. Bulk sample testing further indicates the first phase of dewatering utilizing filter presses would yield a moisture content of approximately 17 percent by dry weight. Therefore, a second phase of dewatering would be required utilizing thermal drying to reduce the moisture content to 14 percent by dry weight. At a moisture content of 14 percent, the tailings should be handleable and, in good weather, trafficable.

EFFECTS OF ALTERNATIVE F

The geotechnical impacts for Alternative F would be the same as identified in Alternative B.

CUMULATIVE EFFECTS

Based on the evaluation of direct and indirect impacts on the project, the construction of Alternatives B, C, D, E, and F would have no cumulative geotechnical impacts.

Construction of access roads and placement of fill material for construction in areas currently susceptible to landslides may add to already unstable conditions and represent a minor cumulative geotechnical impact in those areas only.

SUMMARY

Alternatives A, B, C, D, E, and F include potential consequences associated with seismic, landslide, and avalanche hazards. With the exception of the No Action Alternative, Alternative B and F are expected to have least environmental impact from a geotechnical standpoint.

Alternative D has landslide risks associated with the upper reservoir area and the tailings pipeline alignment extending from the Sweeny Creek tailings area to the mill.

Avalanche risks for Alternative B and F are minimal as compared to Alternatives D and E. Alternative D has avalanche potential associated with the upper reservoir area and the tailings pipeline extending from the Sweeny Creek tailings area to the mill. Tailings disposal Site A (Alternative E) is situated immediately downslope, but outside, of an avalanche runout zone.

Most structures for all action alternatives would have satisfactory foundation conditions. Alternative C includes an access road and transmission line through extensive wetland areas. Alternative C offshore facilities located in Slate Creek Cove, including the dock and possibly the marine terminal facility, may require the installation of deep piles to provide foundation support through potentially soft, liquefiable silt.

SURFACE WATER HYDROLOGY

The Kensington Project would have certain impacts on local surface water hydrology. The activities which could cause impacts on water resources include mine drainage and discharge, waste rock storage, tailings storage facilities, accidental spills, roads, diversion ditches, dams, pipelines, and transportation facilities construction. The impacts on surface quantity and quality associated with each alternative are discussed in the following sections.

EFFECTS OF THE NO ACTION ALTERNATIVE

With this alternative, no impacts associated with mining or milling would take place. One drainage, Sherman Creek, has been impacted by the current exploration activities. A total of about 15 acres are disturbed. The disturbance has resulted from exploration road, adit, and facilities construction. Future impacts from these should be minimal, especially when exploration activities are terminated and reclamation is completed.

EFFECTS COMMON TO ALL ACTION ALTERNATIVES

Water Supply

The Kensington Project would require potable water for domestic use, the mill circuit and for power supply totaling 190 gpm (0.43 cfs). Domestic use requires 35 gpm (0.08 cfs), the mill circuit 48 gpm (0.11 cfs) and power supply 107 gpm (0.24 cfs). An additional 500 to 1,000 gpm (1.4 to 2.28 cfs) will be supplied to the mill circuit from mine drainage. During initial start up, after temporary shutdowns, and following certain maintenance activities, peak water demands of up to 342 gpm (0.78 cfs) could be required (Bechtel, 1991).

An additional 500 to 1000 gpm (1.14 to 2.28 cfs) will be supplied to the mill circuit from mine drainage. Potable water supply for the mill circuit water and domestic needs would be obtained from a diversion dam on upper Sherman Creek and from underground mine drainage. Approximately 1 square mile of watershed would drain to the diversion dam. January and February are low flow months. Average stream flows at the water supply diversion dam for these 2 months are estimated to be 1.8 and 1.3 cfs, respectively (data from 1989 upper Sherman Creek). In units of gpm, the corresponding average stream flows are 808 and 579. The limitation for the water supply would be the quantity of surface water available during the winter months. Low flow conditions in Sherman Creek are quite restrictive. The lowest recorded flow in upper Sherman Creek (monitoring station no. 109) was 0.71 cfs or 319 gpm. Preliminary instream flow requirements in lower Sherman Creek are found in *Table 4-10, Preliminary Instream Flow Requirements for Sherman Creek*. These values range from 6.2 cfs in December, January, and February to 30.8 cfs in June through October. Water withdrawal in Upper Sherman Creek that meets these lower Sherman Creek limitations would mitigate any effects to aquatic life *(See Aquatic Resources, Freshwater)*.

The Applicant has proposed that a backup domestic and mill water supply system would be established by using a combination of available underground mine water and, if necessary, ground water sources in order to mitigate impacts to Sherman Creek. These sources would be available during winter months when surface water supply may be unavailable. Surface water restrictions would be required by ADNR to maintain minimum flows in the downstream areas, or when diversion of stream flows would be difficult due to ice conditions. The proposed water supply system could cause a temporary reduction of flow in Sherman Creek. This temporary flow reduction could be significant during winter low flow periods. After mine closure, flow reduction in Sherman Creek would cease.

Table 4-10, Preliminary Instream Flow Requirements for Sherman Creek

Month	Mean Monthly Flow (cfs)	Minimum Instream Flow Requirements (cfs)
Jan	6.8	6.2
Feb	7.6	6.2
Mar	16.0	9.2
Apr	28.0	20.0
May	47.0	30.8
Jun	61.0	30.8
Jul	37.0	30.8
Aug	50.0	30.8
Sep	46.0	30.8
Oct	44.0	30.8
Nov	20.0	18.5
Dec	6.4	6.2

Sedimentation

Construction activities are potential sources of soil erosion and increased sediment loading to the area streams. During construction, potential for erosion and sediment loading below the project disturbance areas greatly increases. Sediment loading would be greatest during the initial construction period and would be less,

approaching baseline conditions, during operations. The quantity of sediment would be greatest during periods of heavy rainfall (which would mean heavy runoff) especially in areas where vegetative cover has been removed. Actual sediment concentrations would depend largely on prevailing weather conditions as well as the effectiveness of the erosion control practices employed. The minimum disturbed area common to all action alternatives is 46 acres. The following activities comprise this disturbance area.

- Process Area
- Employee Camp
- Lower Portal and Access Area
- Sedimentation Pond
- Marine Terminal at Comet Beach

The Applicant has proposed that non-traveled disturbed areas would be stabilized using a variety of techniques, including mulching and revegetation. All travel areas would be graveled. Sediment from areas affected by construction would be controlled by techniques including straw bale barriers, grass filter waterways, and sediment collection traps in roadside ditches. Concentrated runoff from surface drainage would be routed to sediment basins.

Precipitation runoff from the fuel storage tank area would collect in lined bermed embankments. Collected water would be checked for oil and discharged manually if oil is not present. If oil is present, the flow would be treated in the bermed area (oil skimming/adsorption) or routed through an oil/water separator before being discharged to site runoff channels. Any residual oil will be disposed of off site. Runoff from the mine and mill site area would also be routed to the tailings impoundment or to a special pond for treatment by settling.

A series of Forest Service BMP's (USDA Forest Service, 1991a) addressing erosion control, riparian areas and streambank protection, construction issues (including roads, quarries, borrow pits), snow removal, access and site closure will be included in the final Plan of Operations approved by the Forest Service. The proposed sediment and non-point source water pollution control measures should be adequate to protect the local surface water resources from potential degradation of water quality and quantity. However, the risk of potential sedimentation impacts would vary among alternatives depending on the area disturbed and the potential for sediment to be delivered to surface drainages.

Sewage Disposal

Sewage generation by the operation would vary depending on whether an onsite camp is maintained or not. However, because an onsite camp would be necessary during construction, total domestic wastewater flow is projected to average about 27,000 gallons per day (gpd). The domestic waste stream from the facility would be expected to have similar characteristics to standard high strength domestic sewage. Domestic waste from the underground operation and the surface facilities would be routed to a sump where combined wastes would be pumped to a secondary treatment plant.

Treated effluent would then be routed directly to the marine outfall. The Applicant would need to obtain appropriate permits for sewage disposal and wastewater treatment from ADEC. There would be no significant impacts to surface water resources as the treated effluent is not discharged directly into any fresh water resources. Additionally, treated sewage effluent is such a small percentage (2 percent or less) of the total effluent being discharged through the marine outfall that it has a negligible effect on the quality of the water released into Lynn Canal.

A small septic tank/leach field system would be used to dispose of wastes from the helipad area.

Mill and Tailings Pond Effluent Characteristics

Tailings impoundment effluent quality characteristics were modeled under four scenarios. Alternative B assumes precipitation of metals and settling of solids in the impoundment for 48 hours prior to marine discharge. Alternatives C, D and F (Option 1) assume enhanced pond settling which incorporates the addition of flocculants to the

effluent, water level management, and baffles in the impoundment. Alternative F (Option 2) assumes enhanced pond settling and filtration of the tailings effluent prior to marine discharge. Alternative F (Option 3) assumes enhanced pond settling, chemical precipitation and settling of the CIL circuit tailings stream. Alternative B, C, D and F (Option 1 and 2) assume the use of alkaline chlorination for cyanide destruction and dechlorination, if necessary, prior to discharging mill effluent to the tailings impoundment. Alternatives E and F (Option 3) assume the use of hydrogen peroxide for cyanide destruction. A complete description of the treatment options are included in Chapter 2.

Initially, all 4,000 tons of ore per day would be crushed, ground, and cycled through a flotation circuit. The flotation circuit would use chemical flotation aids and collectors to concentrate gold in the float. The float would be cleaned and routed to a cyanidation circuit for further concentration. It is estimated that approximately 4 to 7 percent of the total ore material (160 to 280 tons of concentrate) per day would undergo cyanidation to extract gold. A list of reagents that would be used in the milling process can be found in *Table 2-2, Chemical and Reagents Use*.

Sodium cyanide is the most potentially toxic reagent to be used at the mill. Cyanide is listed by the EPA as a hazardous material and would be treated to eliminate its hazard potential before process water and tailings are routed to the tailings dam.

Prior to passing through a cyanide destruction unit, cyanide levels in the leach tails could reach levels of 500 to 600 mg/l. Cyanide is highly toxic in the free and dissociated forms.

Weak metal-cyanide complexes in tailings can be soluble in water. However, under aerobic conditions cyanide is quickly converted to nitrates through biological oxidation. Under anaerobic conditions cyanide in the tailings would break down through denitrification to form gaseous nitrogen compounds. The movement of cyanide through soils and ground water is very limited due to these biological degradation processes and formation of stable cyanide-metal complexes including ferro-cyanides (USDI, undated).

Metals would be present in soluble form in the wastewater. High lime dosages in the milling and alkaline chlorination process would precipitate most trace metals.

Lead nitrate is one of the primary chemicals used in the mill flotation/separation process. A soluble salt of lead, lead nitrate would be added in very small amounts in the primary flotation circuit. Lead is relatively insoluble and excess or nonreactive lead cations would form insoluble compounds (sulfates primarily). Laboratory data (*Lakefield, 1990*) indicates that approximately 95 to 99 percent of all the lead in the process effluent will be in the particulate solid form.

Xanthate residues of up to 2 mg/l can occur in waters associated with flotation mill tailings. Frothers are generally more volatile and are not anticipated to occur in substantial quantities. Xanthates can be toxic at levels above 0.1 mg/l but are unstable in aqueous solutions and break down to carbon disulfide which is highly volatile and would rapidly dissipate over the surface of the pond.

Because the Kensington Project is located in a net precipitation area (an area where net precipitation exceeds net evaporation), a certain amount of water would be allowed to be discharged to Lynn Canal under terms set by an NPDES Permit. Any discharge must be monitored according to the provisions of the NPDES Permit to ensure that established water standards are met (*See Appendix D, Draft NPDES Permit*).

Modeling

The effluent water quality for Alternatives B, C, D, and F were modeled in order to predict the ability of these treatments to meet draft NPDES permit levels and to describe subsequent impacts in marine waters. Alternative E effluent concentrations were estimated.

A description of the model, complete assumptions, and results are found in JMM (1992). Levels of metals, total cyanide, and suspended solids were included in the model. The effluent predictions are made for each month over a 24 month period. The model accounts for monthly variation in the quantity of

flow from mine drainage and undiverted surface water drainage. The assumption is made that the mill effluent water quality is constant in all months. Three water sources are included in the tailings impoundment effluent: mill effluent, mine drainage and undiverted surface water drainage. Mill effluent water quality data was taken from 48-hour tailings decant water samples (Lakefield, 1990). Water quality from the mine drainage was represented by average water quality data from the existing settling pond (monitoring station 101). Suspended solids for surface runoff into the impoundment was estimated using data from other monitored sites, and weighing it to account for the percent of the runoff area in undisturbed ground, in developed millsite, and in tailings beach. Water quality for the mill effluent was based on testing by Lakefield (1990). For Alternative B, it was assumed that the concentration of metals achieved in the 48 hour decant test would be achieved after 48 hours settling time in the tailings impoundment. The tailings impoundments are actually designed for a 5 day settling time. For Alternatives C, D, and F it was assumed that the percent of metals which would settle would vary accordingly to their solubility. For suspended solids the assumption was made that enhanced settling would remove 75 percent of the raw tailings concentrations Lakefield (1990). Additional water treatability studies will be conducted to determine what treatment is necessary to meet NPDES permit levels. The model results should be considered as comparisons, not as definitive numbers.

Included in the draft NPDES permit is a stormwater exemption which allows for discharge of wastewater above numerical criteria during events of the 10 year-24 hour magnitude and greater.

The model includes the recycle of water proposed in the Bechtel (1991) water balance which will result in the gradual build up of solids and metals in the pond. Particulate removal in the tailings impoundment by settling (without enhancement) was assumed based on information from other operations and Lakefield data (JMM, 1992). A minimum pond settling time of 48 hours (minimum pond detention time) was used in the assumptions. An additional 50 percent total cyanide loss due to pond processes was also assumed (JMM, 1992). The final combined pond water (inflow from the mill, mine, and surface water) is either used as recycle water to the mill process or discharged into Lynn Canal through the marine outfall. The effluent volume discharged to the Lynn Canal varies monthly as a function of surface runoff and mine water discharge (JMM, 1991).

Estimated concentrations of parameters that could be present in the tailings pond effluent are displayed in *Table 4-11, Estimated Water Quality for the Mill and Tailings Impoundment Effluent - Alternatives B, C, D, and F*. The predicted effluent concentrations should be compared with the Draft NPDES and marine aquatic life standards shown in *Table 4-12, Draft NPDES Permit Limits and Marine Aquatic Life Standards*. All treated effluent is proposed to be discharged through a marine outfall. (*See Aquatic Resources - Marine, Chapter 4*). Under normal operation, no impacts to Sherman or Sweeney creeks would occur since there would be no discharge to the creek. However, there is a remote possibility of an accidental system failure which is addressed in the following section.

Accidental Spills

The only pathway for contamination of surface water streams from potentially toxic effluent would be from an accidental spill or rupture of either the marine discharge pipeline. A rupture of the marine discharge pipeline would release treated water from the tailings pond.

Accidental spills of mill or tailings effluent could impact surface and ground water quality by cyanide heavy metal contamination. Metal ions in the tailings pond effluents that are projected to reach concentrations above acute or chronic toxicity criteria for fresh water organisms include copper, lead, and zinc. Water quality criteria used for this determination were derived from EPA (1976 and 1986) and the Federal Register (45 FR 11-28-90, 50 FR 7-29-85). For hardness dependent criteria average hardness (42 mg/l) for upper Sherman Creek, Station 109 was used. However, metal ions that approach toxic concentration level in mill or tailings pond effluent (lead, zinc, copper) have very low solubility in neutral or alkaline waters and low to negligible mobility under environmental conditions associated with ground water and

Table 4-11, Estimated Water Quality for the Mill and Tailings Impoundment Effluent, Alternatives B, C, D and F

Parameter[1]	Alternative B[2]			Alternative C, D and F (Option 1)[3]			Alternative F					
							Option 2[3,6]			Option 3[3,4]		
	Low	High	Average	Low	High	Average	Low	High	Average	Low	High	Average
Aluminum (Al)	**0.284**	**0.956**	**0.621**	**0.286**	**0.997**	**0.636**	**0.190**	**0.640**	**0.416**	**0.261**	**0.480**	**0.364**
Arsenic (As)	**0.005**	**0.010**	**0.008**	**0.005**	**0.011**	**0.008**	**0.003**	**0.007**	**0.005**	**0.005**	**0.006**	**0.006**
Beryllium (Be)[5]	0.001	0.002	0.002	0.001	0.002	0.002	0.001	0.002	0.001	0.001	0.001	0.001
Cadmium (Cd)[5]	0.003	0.007	0.005	0.003	0.007	0.005	0.002	0.005	0.003	0.003	0.004	0.003
Chromium (Cr)	**0.020**	**0.039**	**0.031**	**0.020**	**0.040**	**0.031**	**0.013**	**0.026**	**0.021**	**0.020**	**0.022**	**0.021**
Chlorine (Cl)	**0.014**	**0.064**	**0.034**	**0.014**	**0.067**	**0.039**	**0.014**	**0.067**	**0.039**	**0[7]**	**0[7]**	**0[7]**
Cobalt (Co)[5]	0.004	0.016	0.010	0.004	0.017	0.010	0.002	0.011	0.007	0.003	0.010	0.007
Copper (Cu)	**0.021**	**0.067**	**0.044**	**0.021**	**0.070**	**0.045**	**0.018**	**0.057**	**0.037**	**0.019**	**0.038**	**0.028**
Lead (Pb)	**0.028**	**0.077**	**0.054**	**0.029**	**0.080**	**0.055**	**0.003**	**0.008**	**0.005**	**0.027**	**0.037**	**0.031**
Manganese (Mn)[5]	0.111	0.351	0.223	0.112	0.345	0.228	0.074	0.222	0.149	0.105	0.183	0.141
Mercury (Hg)[5]	0.001	0.002	0.002	0.001	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001
Nickel (Ni)	**0.014**	**0.036**	**0.025**	**0.014**	**0.037**	**0.026**	**0.009**	**0.024**	**0.017**	**0.013**	**0.021**	**0.017**
Selenium (Se)[5]	0.046	0.196	0.119	0.047	0.204	0.122	0.031	0.131	0.080	0.043	0.120	0.079
Thorium (Th)[5]	0.021	0.096	0.067	0.022	0.100	0.059	0.014	0.064	0.038	0.019	0.059	0.038
Zinc (Zn)	**0.018**	**0.057**	**0.038**	**0.019**	**0.060**	**0.039**	**0.009**	**0.029**	**0.019**	**0.017**	**0.028**	**0.022**
Total Cyanide	**0.018**	**0.069[8]**	**0.043**	**0.009**	**0.031**	**0.018**	**0.009**	**0.031**	**0.018**	**0.016**	**0.034**	**0.024**
TSS	**37.961**	**127.099**	**81.663**	**4.932**	**7.015**	**5.826**	**0.513**	**0.799**	**0.636**	**8.357**	**16.225**	**11.806**

[1]Concentrations in mg/l unless otherwise noted.
[2]48 hour pond treatment.
[3]Assumes enhanced settling by flocculent addition and pond flow management prior to discharge.
[4]Chemical treatment of leach circuit effluent.
[5]Concentrations are over estimated due to using detection limits for initial calculations.
[6]Includes filtration of entire effluent stream.
[7]Assumes H_2O_2 treatment of leach circuit filtrate.
[8]Actual concentrations would probably be lower due to natural degradation.

Table 4-12, Draft NPDES Permit Limits and Marine Aquatic Life Standards

Parameter[1]	Draft NPDES Permit Limits[2]		Marine Aquatic Life Standards	
	Daily Ave	Monthly Ave	Marine	Fresh[3]
Aluminum (Al)	NL	NL	NL	NL
Arsenic (As)	5.6[4]	3.41[4]	0.036	0.050
Beryllium (Be)	NL	NL	NL	NL
Cadmium (Cd)	0.16[4]	0.05[4]	0.0093	0.001
Chromium (Cr)	8.2[4]	5.0[4]	1.10	0.01
Chlorine (Cl)	0.2	0.08	0.001	0.002
Cobalt (Co)	NL	NL	NL	NL
Copper (Cu)	0.15[4]	0.09[4]	0.0029	0.012
Lead (Pb)	0.6[4]	0.3[4]	0.0066	0.0032
Manganese (Mn)	NL	NL	NL	NL
Mercury (Hg)	0.002[4]	0.001[4]	0.000025	0.000012
Nickel (Ni)	1.07[4]	0.65[4]	0.0083	0.096
Selenium (Se)	11.66[4]	7.1[4]	0.054	0.055
Thorium (Th)	NL	NL	NL	NL
Zinc (Zn)	1.5[4]	0.75[4]	0.086	0.057
Total Cyanide	0.1	0.06	0.001	0.005
TSS	30	20	NL	NL

NL - No limit set in draft NPDES Permit.
[1]Concentrations in mg/l unless otherwise noted.
[2]See Appendix D.
[3]Limits are hardness dependent for metal ions typical values present.
[4]Measured as total recoverable.

surface waters in the Kensington Project area (USDI, undated).

Cyanide concentrations estimated for both tailings pond and mill effluents are slightly above fresh water chronic levels (EPA, 1986). Actual levels of toxic cyanide compounds released from an accidental effluent spill or tailings pond seepage are likely to be very low due to natural cyanide degradation in the pond.

Ammonia and nitrate are final cyanide degradation products. Ammonia concentrations in the tailings pond could approach 32 mg/l. (Clay, 1991). Chronic toxicity levels for Sherman Creek, assuming a pH of 7.5 and temperatures between 0 and 20 degrees C range from 1.5 to 2.5 mg/l (EPA, 1986).

Ammonia is converted to nitrites and nitrates through bacteriological oxidation under aerobic conditions. However, breakdown of high concentrations of ammonia in natural waters is a slow process due to low numbers of nitrifying bacteria and low detention times. Therefore, accidental spillage of tailings pond effluent into surface waters could result in a significant water quality impact from higher concentrations of ammonia.

Accidental spills of ore processing reagents or fuel could occur at or enroute to the Kensington Project site. There is also a possibility of a rupture or leakage of the tailings slurry, return water, effluent discharge, or LPG pipelines. The effects of accidental spills or ruptures would depend on the nature and volume of the material spilled, whether the spilled material would reach surface water, the flow volume of a receiving stream, and the effectiveness of the spill countermeasure response. For a discussion of spill impacts on fisheries see *Aquatic Resources - Freshwater* and *Aquatic Resources - Marine, Chapter 4.*

The potential for contamination of the environment by the breakage or rupture of the pipelines would have to be considered during

design and construction. Daily visual inspections as well as instrumental monitoring would be required and continuous balancing of flow at the mill and process area would be necessary. As well as constant instrumental monitoring, these operational procedures would also provide a method for evaluating the potential for leakage. Weather conditions, final design characteristics of the pipelines, and the efficiency of emergency shutdown procedures would determine the potential for contamination of surface water resources. Another concern would be a rupture of the tailings slurry pipeline (Alternative D) that would cause sediment loading to either Sherman Creek or Sweeny Creek, and subsequent water quality impacts to wildlife and aquatic life.

Pipelines would be located to avoid surface water streams wherever possible. The potential for pipeline ruptures from geologic hazards are discussed in the Geotechnical Considerations Section. The probability of a rupture in the pipelines would, in part, be proportional to the length of pipeline required in each alternative. Leak preventative design measures for the pipelines and facilities, and for the SPCC Plan developed for the Kensington Project should minimize the potential for accidental spills and subsequent impacts.

The potential impacts from a worst case pipeline break are analyzed for each alternative in the appropriate sections.

Underground Mine Drainage

The mine discharge would be collected in a sediment pond or in the tailings impoundment when the sediment pond is inundated. The sediment pond water would be recycled to the mill and/or treated and discharged under the NPDES Permit through the marine outfall via the tailings impoundment. Water quality monitoring during the mining operation would indicate if mine waters could be discharged to Sherman Creek without treatment after closure of the mine. (*See Ground Water Hydrology*). No surface water contamination from the mine water discharge is anticipated.

Waste Rock Disposal

All action alternatives consider temporary or permanent waste rock storage within the project area. Waste rock would be used in the construction of tailings embankments and road surfacing in all alternatives except Alternative D (Sweeny Creek). A permanent waste rock storage would be required in the Sherman Creek drainage for Alternative D. Temporary waste rock storage would be used in the other alternatives. Surface flow over the development waste rock stockpiles would be controlled and routed to sediment ponds or other sediment control structures. Contributions of sediment or leachate from waste rock storage to local surface water streams from waste rock stockpiles are not expected to be significant. (*See Ground Water Hydrology, Chapter 4*).

EFFECTS OF ALTERNATIVE B

Alternative B (Applicant Proposal) would restrict all impacts associated with the Kensington Project to the Sherman Creek watershed. In addition to the common impacts discussed above, Alternative B would include a tailings impoundment to be constructed on Sherman Creek and diversions of upper Sherman Creek, an unnamed tributary to Sherman Creek, and Ophir Creek around the tailings impoundment.

The Applicant proposes to pass the tailings through a cyanide destruction process (alkaline chlorination) prior to mixing the flotation and cyanidation tailings. The alkaline chlorination process produces carbon and nitrogen end products, sodium bicarbonate, nitrogen, sodium chloride, and water, all of which are nontoxic. Excess chlorine, a reactive chemical, could also be present in the tailings stream. By-products of chlorine are described in JMM (1992).

Site Development

The total area disturbed in Alternative B is 275 acres. There are about 2.0 miles of disturbed stream channel, 2.8 miles of pipelines, and 2.1 miles of stream channel diversion structures under this alternative.

Initial construction for Alternative B would include roads, camp and mill facilities, a water supply diversion and storage facility on upper

Sherman Creek, diversion channels around the tailings Impoundment, drainage and sediment control structures and temporary waste rock storage. The total area disturbed in Alternative B is 275 acres. There are about 2.0 miles of disturbed stream channel, 2.8 miles of pipeline (1 mile of changed effluent pipeline, 1.8 miles of LPG pipeline), and 1.5 miles of stream channel diversion structures under this alternative. Construction activities would temporarily increase sedimentation in local streams. Drainage and sediment control plans would reduce impacts to local streams. Construction activities during periods of heavy rainfall or snowmelt should be closely coordinated with these sediment control plans to minimize the impact.

Tailings Disposal

Upper Sherman Creek flows, including flows from the small unnamed tributary entering Sherman Creek from the southeast, would be diverted from the south side of the tailings impoundment via a buried pipeline sized to convey the 25-year, 24-hour storm event of 166 cfs.

The Ophir Creek diversion would be sized to convey the PMF of 1,245 cfs. It would require two diversion structures, a diversion channel along the side slope above the north side of the impoundment and a concrete spillway that returns diverted flow to Sherman Creek below the impoundment. Significant energy dissipation would be required in the spillway and where diverted flow re-enters lower Sherman Creek.

Temperature alteration in lower Sherman Creek due to the removal of vegetation canopy and alteration of flow patterns of the diverted flow from Ophir Creek is not expected to be significant. According to Everest and Harr (1982), southeast Alaska is not located in a high risk zone for solar heating of exposed stream reaches. Using a method outlined in Brown (1970), this general statement regarding the effect of canopy removal along the Ophir Creek diversion on temperature in lower Sherman Creek was confirmed (Shangraw, 1992). Even though the impact from increasing temperature in the low flow summer period seems slight, continuous measurement of temperature has been initiated in lower Sherman Creek (*See Chapter 3, Surface Water Hydrology*).

Undiverted surface runoff from the tailings impoundment basin would be routed through a diversion conduit alongside the original creek bed during construction of the tailings embankment. The diversion conduit would form part of the system used to release net precipitation from the tailings facility during operations. Within the facility, the upstream end of the conduit would be connected to a valved decant system. Downstream of the embankment the discharge would be conveyed to the marine outfall (Knight and Piesold, Ltd., 1990).

Worst case scenarios for a tailings dam failure (*See Geotechnical Considerations, Chapter 4*) indicate that a 17,000 cfs peak discharge, equivalent to 10 times the probable maximum flood for the watershed, could be delivered to Sherman Creek. An estimated 215,000 tons of tailings would be removed from the impoundment. Massive quantities of soil and rock debris would also be entrained as the flood peak scoured the stream channel and upper channel sideslopes. Additional debris loading from shallow mass wasting of channel sideslopes would likely contribute additional sediment to the flood flow in Sherman Creek. This is a worst case scenario and is **not** expected to occur.

The amount of material entrained in this debris flow was estimated to be five times the quantity of tailings washed out from behind the dam (Hydro-Geo Consultants, Inc., 1991). Therefore, the potential toxic effects of the released tailings would be minimal because of mixing with inert sediments. Physical destruction to stream habitat in Sherman Creek would be very serious. Pools would fill with debris and spawning gravels would be covered by several feet of sediments. It would take many years for stream habitat to return to a stable condition.

After mine closure, the Sherman Creek and Ophir Creek diversions would be removed. Both streams would be reconstructed and routed through the tailings facility. The reconstructed channels would be sized for PMF and engineered as self-maintaining channels. Flow in the reconstructed Sherman and Ophir

creeks channels would be routed to the final surface pond and then around the north side of the tailings facility to the concrete spillway chute. Permanent erosion control measures would be taken to protect surface waters from turbidity originating from disturbed areas. A program for regular inspection and maintenance of constructed channels and the spillway, would be required in perpetuity after mining is terminated.

Effluent Water Quality

Alkaline chlorination treatment units can reduce cyanide levels to approximately 0.5 to 2 mg/l (*Lakefield, 1990*). Dilution with flotation waste would reduce cyanide concentrations to approximately 0.05 to 0.1 mg/l within the tailings pond. Further reduction of cyanide would occur as a result of exposure to air and sunlight and also by dilution due to precipitation within the tailings pond.

Effluent water quality under Alternative B would meet all draft NPDES permit limitations for metals. The maximum projected value for total cyanide slightly exceeds the monthly average limitation. The draft NPDES limitations for TSS would not be met under Alternative B. (*See Table 4-11, Estimated Water Quality for the Mill and Tailings Impoundment Effluent - Alternatives B, C, D, F*).

Accidental Spills

Pipeline breaks pose a potential water quality concern for Sherman Creek. Approximately 4,700 feet of the tailings effluent pipeline would be capable of discharging potentially toxic concentrations of some metals, cyanide and ammonia into Sherman Creek. Under a worst case situation where 100 percent of the spill directly enters a surface drainage channel and discharge continues for more than 1 hour after the break occurs, significant short term water quality impacts that exceed acute toxic criteria could be anticipated during low flow conditions.

Locating the tailings pond in the Sherman Creek drainage below the proposed mill site would provide an additional layer of protection for surface water. The tailings pond would serve as backup containment (to in plant measures) for any material spills in the process plant. The containment would only be effective if project personnel close the tailings pond decant immediately following a spill.

EFFECTS OF ALTERNATIVE C

The majority of the facilities would remain in the Sherman Creek drainage, as presented in Alternative B, however, a road would be constructed from the Sherman Creek site to Slate Creek Cove in Berners Bay. Tailings disposal and water supply impacts would be the same as presented in Alternative B. The total acreage disturbed in Alternative C is 392 acres. There are about 2.0 miles of disturbed stream channel, 10.0 miles of pipelines, and 2.1 miles of stream channel diversion structures under this alternative. The spillway which returns diverted flows to Sherman Creek would be riprapped instead of concrete lined as indicated for Alternative B.

Site Development

The total acreage disturbed in Alternative C is 392 acres. There are about 2.0 miles of disturbed stream channel, 10.0 miles of pipeline (1 mile of effluent pipeline, 9 miles of LPG pipeline), and 2.1 miles of stream channel diversion structures under this alternative. Construction of the access road to Berner's Bay (117 acres) would have an effect on stream courses along the proposed route. The major drainage to be crossed would be Sweeny Creek. Small or transitory drainage courses would pass under the road in culverts. The culverts would be spaced to keep water from pooling on the uphill side of the road. Spacing would minimize flow concentrations below the culverts. Surface and subsurface runoff would be intercepted by the road and routed a few hundred feet before being allowed to proceed downhill. Flow spreading devices and natural infiltration of runoff through vegetation and subsoil below the culvert crossings would need to be incorporated to minimize erosion and overland flow to the streams. An LPG pipeline would also be constructed along the access road.

Runoff at the marine terminal facility in Slate Creek Cove would have to be controlled to minimize impact to the waters in Slate Creek Cove. Sedimentation ponds or other sediment

control devices would be required to minimize sediment loading or turbidity. Increased turbidity and sediment loading could be expected during construction of the road to the marine facility in Slate Creek Cove. Extraction of rock from rock quarries enroute could also increase turbidity and sediment loading. However, the turbidity and sedimentation should decrease substantially after initial construction. Again, Forest Service BMPs regarding road construction, erosion control and streambank protection would need to be implemented. These will be specified in the final Plan of Operations.

Tailings Disposal

Tailings disposal varies from Alternative B only with regard to the spillway. The spillway returning flows to Sherman Creek below the tailings impoundment would be lined with riprap. This spillway would provide effective energy dissipation and would require maintenance to minimize gullying and sedimentation. A riprapped spillway would be constructed to resemble natural conditions.

The surface area disturbed by a riprap spillway would be at least twice as much as that required by a concrete spillway. Additional ground disturbance would be required if the source for the riprap were within the project area but outside the impoundment area. There are differing opinions on the longevity and stability of the two channel surfacing methods, and the frequency and cost of repairs (Knight & Piesold, 1991, Paul & Hartsog, 1991). Both surfacing methods would require perpetual maintenance, which would be financed by the applicant.

Effluent Water Quality

The impacts from effluent water quality would be the same as described for Alternative F, Option 1. Effluent water quality under Alternative C meets all draft NPDES permit limitations.

Accidental Spills

The impacts from accidental spills would be the same as Alternative B.

EFFECTS OF ALTERNATIVE D

Two major drainages in the area would be affected by this alternative: Sherman Creek and Sweeny Creek. The tailings impoundment would be located in Sweeny Creek. This alternative would require additional access roads, a permanent waste rock disposal area, and a rock quarry located near the tailings dam.

Site Development

Site development would be similar to that described for Alternative B, but both Sweeny and Sherman creeks would be affected. The total area disturbed in Alternative D would be 229 acres. There are 1.7 miles of disturbed stream channel, 3.6 miles of pipeline (1.2 miles of effluent pipeline, 2 miles of tailings slurry pipeline, and 0.4 miles of LPG pipeline), and 1.1 miles of stream channel diversion structure under this alternative. Construction in the Sweeny Creek drainage would include the tailings impoundment, quarries and borrow pits for construction materials, diversion of Sweeny Creek around the tailings facility, and a slurry pipeline to transport tailings from the mill to the impoundment.

The steep slopes surrounding the Sweeny Creek tailings impoundment would be susceptible to erosion and stability problems. The borrow pits are located in flatter areas of the drainage and are not close to Sweeny Creek. Potential for contribution of sediment to the stream for this source is not significant. The tailings pipeline would follow hillside contours. If this pipeline is ruptured by landslide activity tailings would eventually discharge into surface streams.

Tailings Disposal

The development of a Sweeny Creek tailings impoundment would require diversion of runoff and stream flow. The sidehills in Sweeny Creek are relatively steep, requiring diversion channel designs based on topographic constraints. The diversion on the east side of Sweeny Creek would be sized for a PMF (1,811 cfs). An increase in turbidity and sediment loading could be expected in Sweeny Creek as a result of this construction. The tailings embankment in Sweeny Creek is projected to be 370 feet high.

Energy dissipators in the riprap spillway below the impoundment would reduce returned flow velocities into Sweeny Creek.

Impacts from failure of the Sweeny Creek tailings impoundment would be similar to those described for the Sherman Creek tailings dam failure scenario.

Effluent Water Quality

The impacts from effluent water quality would be the same as described for Alternative F, Option 1. Effluent water quality under Alternative D meets all draft NPDES permit limitations.

Accidental Spills

The possibility of a tailings pipeline rupture increases in Alternative D because this alternative has 2 miles of tailings slurry pipeline from the mill to the Sweeny Creek impoundment, not found in any other alternative.

Approximately 4,000 feet of the Sweeny Creek tailings slurry pipeline could potentially discharge into a tributary of Sherman or Sweeny creeks if a major pipeline break occurred. This alternative would also require a tailings effluent line along Sweeny Creek. Approximately 3,000 feet of this effluent line could potentially spill into Sweeny Creek. A major tailings slurry spill directly into Sweeny Creek would likely result in significant short term water quality impacts.

The Sweeny Creek tailings impoundment would not provide the backup protection against spills that the Sherman creek location provides in Alternative B, C, and F.

EFFECTS OF ALTERNATIVE E

As in Alternative B, Alternative E (Dewatered Tailings) would restrict all impacts of the project to the Sherman Creek drainage. With the exception of impacts associated with the Sherman Creek tailings impoundment, which would be eliminated, all other impacts would be the same as Alternative B.

Site Development

Development of the site under this alternative would vary from the previous descriptions because of the tailings location. This alternative would not require any stream channel diversions for construction of the tailings impoundment. However, drainage and sediment control structures would still be needed around the tailings disposal area. The total surface area disturbed in Alternative E would be 237 to 243 acres. There would be no disturbance to existing stream channels. This alternative would require 2.2 miles of pipeline (Site A, 0.4 miles of effluent pipeline, 1.8 miles of LPG pipeline) or 1.9 miles of pipeline (Site B, 0.1 miles of effluent pipeline, 1.8 miles of LPG pipeline) and 0.9 mile of upland flow diversion channels.

Tailings Disposal

There are two alternative site locations for dewatered tailings disposal. Site A is located on a hillside above Sherman Creek. Its proximity to Sherman Creek could contribute sediment to the stream in the event of a failure of the pile. (*see Geotechnical Considerations*). Site B is located on the more moderate slopes adjacent to Lynn Canal. Failure of the pile on site B would increase sediment loading in Lynn Canal. Diversion of surface water flows around both proposed dewatered tailings disposal sites would be required. The seepage pond below both tailings sites would need to be cleaned regularly as they would accumulate sediment from direct runoff of the tailings. Erosion and gully formation on the tailings pile at either site could be a significant maintenance problem due to the fine nature of the compacted tailings. The potential for erosion would decrease once vegetation cover is established after reclamation.

A sedimentation pond, adjacent to the mill site, would be required to accommodate mine drainage and surface runoff and recycling of process and wastewater. It is possible that a major seismic event could cause a failure of the dewatered tailings embankment resulting in minor amounts of downslope movement of dewatered tailings. (*See Geotechnical Considerations, Chapter 4*). It is very unlikely that significant quantities of tailings from site A

would be transported to Sherman Creek. Potential impacts from mass wasting of the tailings pile at site A are, therefore, minimal. Failure of the site B dewatered tailings facility also has low potential for affecting water quality in Sherman or Sweeny creeks.

Effluent Water Quality

Effluent water to Lynn Canal would be generated from three sources, the dry tailings area settling pond, any process area storm water (surface, snowmelt) runoff, and water discharged from the ore milling process. The dry tailings disposal area would be graded and provided with surface runoff diversions to eliminate as much contact with the dewatered tailings as possible; however, the 170 acres projected as necessary for the disposal of all the tailings material produced would generate a significant amount of surface runoff and drainage as a result of incident precipitation and snowfall.

The average annual runoff collected by the tailings pond was estimated to be approximately 1,300 acre-ft.

Trace cyanides in a compacted dry tailings (moist at 70 to 80 percent solids in place) will be more likely to remain in the material for a longer period. Testing conducted with spent cyanides contained in washed waste rock indicates that natural cyanide volatilization/ destruction occurs faster if the material is allowed to age uncompacted in the presence of oxygen and sunlight before final in-place stabilization. Ideally a thin (12 to 18") lift of material should be placed and allowed to sit for several days (5 to 10) before compacting in place. In an area such as Kensington with severe climatic conditions, this may not be practical from an operational standpoint and material may have to be compacted at the time of placement to maintain the correct moisture density relationship. Any residual cyanide discharged to the tailings/sedimentation pond would be in the form of strong acid dissociable cyanide - very stable metal cyanide complexes. These materials will undergo very little further degradation in the sedimentation pond other than settling in the case of insoluble iron cyanide solids. These materials are considered environmentally unavoidable and benign.

Additional discharge sources would include site drainage and surface runoff which would contribute to the tailings disposal area. Because of the diversions discussed previously and the location of the tailings area this is expected to be minimal.

Another effluent source would be water discharged from the ore milling circuit in order to prevent solids and salt buildup. The volume of this discharge would be expected to be in the range of 200-300 gpm. This discharge would be treated in a manner similar to the CIL circuit treatment described in Alternative F (chemical precipitation and solids removal). The total effluent flow from the combination of the three sources would range from a low of approximately 900 gpm to a projected maximum of approximately 5,000 gpm. The water quality of this effluent would be dependent upon the ability to place and stabilize the dry tailings material; the water quality characteristics of the runoff and the effectiveness of removal in the settling pond. Additional wastewater treatment might be needed to meet draft NPDES permit limits.

The geotechnical evaluation of the stability of the in-place dry tailings (Knight and Piesold,Ltd., 1991), indicated that the material would be subject to erosion under intense precipitation events. Based on these projections, it would be assumed necessary to provide a relatively large settling pond (2 to 3 acres) and some form of final treatment (filtration or chemical treatment) to meet the effluent water quality objectives.

Accidental Spills

The marine outfall would be connected by pipeline to the process and camp area. The pipeline would be roughly twice as long as the pipeline exiting from the Sherman Creek tailings impoundment thus increasing the probability of failure. Site B has approximately 8,000 feet of mill pond effluent pipeline that could potentially spill into Sherman Creek, while Site A has 5,200 feet of effluent pipeline that could result in a major spill in the Sherman Creek drainage. Water quality impacts from such a spill would be identical to those described for Alternatives B and C.

The dewatered tailings disposal would not provide the level of backup spill protection that the Sherman Creek location in Alternatives B, C, and F provides. However, the sedimentation pond located below the process area would serve in a similar capacity as the tailings impoundment.

ALTERNATIVE F

Alternative F is the same as applicants proposal with two exceptions; the marine outfall is located south of Point Sherman and three water treatment options are presented. Option 1 includes enhanced settling in the pond using water level management and baffles. Alkaline chlorination would be used for cyanide destruction. A dechlorination circuit would follow alkaline chlorination. This option focuses on removal of suspended solids from the effluent stream. Metals would also be removed as they exist in particulate form. Option 2 includes enhanced settling in the pond followed by filtration of the whole effluent stream. Alkaline chlorination followed by dechlorination would be used for cyanide destruction. This option focuses on further enhancing suspended solids and other particulates removal. Option 3 includes chemical precipitation/settling of leach circuit effluent prior to disposal in the tailings pond. Cyanide destruction under this option would be through hydrogen peroxide treatment of the liquid separated from the leach circuit solids. This option focuses on converting dissolved metals into particulate form for removal.

Site Development

The total surface area disturbed in Alternative F would be 277 acres. Impacts from site development would be the same as Alternative B except an additional two acres would be disturbed for the construction of a water treatment plant.

Tailings Disposal

Impacts from the tailings disposal would be the same as described in Alternative B.

Effluent Water Quality

The three treatment scenarios are presented to provide a reasonable range of expected effluent water quality, and to compare the effectiveness of using feasible treatment methods.

Additional study would provide information used in the final design process. Specific treatments, such as types of flocculants, and need for filtration, would be based on these studies.

Results from the options modeled here are presented in *Table 4-11, Estimated Water Quality for the Mill and Tailings Impoundment Effluent - Alternatives B, C, D, and F*. The effectiveness of each option in reducing constituents is shown in *Table 4-13, Water Treatment Process Comparison*. Option 2, representing filtration below the impoundment, provides the lowest concentrations of total cyanide, lead, zinc, and suspended solids. Option 3 provides the same or slightly lower concentrations (than Option 2) for the monthly average and high values of other metals. According to this modeling, all three options meet draft NPDES criteria.

Additional work to optimize gold extraction could lead to development of other options that would also meet NPDES Permit limitations.

Accidental Spills

Affects on Sherman Creek due to an accidental spill or rupture could still have the short term water quality impacts described for Alternative B because the filtration plant would be constructed near the beach area. Water quality in the effluent pipeline would be slightly better than Alternative B due to the enhanced settling option in the tailings impoundment, but slightly worse than Alternative F results shown on *Table 4-11, Estimated Water Quality for the Mill and Tailings Impoundment Effluent, Alternatives B,C, D and F* because the filtration would not yet have taken place.

The potential for backup spill protection would be the same as described for Alternative B.

Table 4-13, Water Treatment Process Comparison

Parameter	Alternative B Concentration[1]	Alternative F, Option 1		Alternative F, Option 2		Alternative F, Option 3	
		Concentration[1]	Removal Eff.[2] (%)	Concentration[1]	Removal Eff.[2] (%)	Concentration[1]	Removal Eff.[2] (%)
Arsenic (As)	0.010	0.011	0	0.007	30	0.006	40
Chromium (Cr)	0.039	0.040	0	0.026	33	0.022	44
Copper (Cu)	0.067	0.070	20	0.057	15	0.038	43
Lead (Pb)	0.077	0.080	0	0.008	90	0.037	52
Nickel (Ni)	0.036	0.037	0	0.024	50	0.021	50
Zinc (Zn)	0.057	0.060	0	0.029	49	0.028	51
Total Cyanide	0.069	0.031	55	0.031	55	0.034	51
TSS	127.099	7.015	95	0.799	99	16.225	88

Note: All concentrations are in mg/l
[1]Based on high values from 25 month model by JMM (1992).
[2]Removal efficiencies compared to Alternative B.

CUMULATIVE EFFECTS

The Jualln Project Is located in the Johnson Creek drainage immediately west of the Sherman Creek dralnage. If the Jualin Project is developed Into a mining operation, there should be no cumulative surface water impacts associated with the actual mining or ore processing activities from the two sites. Johnson Creek drains into Berners Bay, while Sherman Creek and Sweeny Creek drain into Lynn Canal. Some minor cumulative water quality Impacts could occur if two marine terminals are located in the Slate Creek Cove area (Alternative C, Berners Bay Access). Presently, the Jualin exploration project has a small marine facility on the east side of Slate Creek Cove with a laydown area several hundred yards from the beach.

SUMMARY

The impact of water withdrawal from Sherman Creek on instream flows during low flow periods is common to all alternatives. The proposed alternative water supply source from ground water and/or mlne water would mitigate effects to instream flows.

Effects of sedimentation from site development activities would also be common to all alternatives. Construction activities may temporarily increase sedimentation in local streams. The risk of sedimentation is related to the soil types, amount of disturbance, and the proximity of construction to the streams. Drainage and sediment control plans would minimize the impacts from sedimentation.

Alternatives B, C, D, and F have conventional tailings disposal in tailings impoundments, either in Sherman or Sweeny creeks. Diversion of Sherman and Sweeny creeks around these impoundments and reclamation of stream channels after mine closure are also common to Alternatives B, C, D, and F. Alternative E does not require diversion of stream channels around the two dewatered tailings disposal site options (A and B).

Alternative B would exceed the draft NPDES limitations set for TSS and slightly exceed the limitations for total cyanide. Alternative F, Options 1, 2, and 3 meet all draft NPDES limitations. All alternatives would require a mixing zone to meet marine aquatic life standards. Effects of a mixing zone are discussed under *Aquatic Resources - Marine, Chapter 4.*

Accidental spills from the marine outfall pipeline (all alternatives) or tailings slurry pipeline (Alternative D, Sweeny Creek) could cause short term water quality impacts to Sherman and Sweeny creeks. A major break could cause water quality parameters to exceed acute fresh water toxicity criteria. The risk associated with a pipeline rupture is related to the length of pipeline exposed to natural and operational hazards and the proximity to drainage channels.

GROUND WATER HYDROLOGY

The Kensington Project would have certain impacts on local ground water hydrology. The activities which could cause impacts on water resources include mine drainage and discharge, waste rock storage, tailings storage facilities, accidental spills, roads, diversion ditches, dams, pipelines, and transportation facilities construction. The potential impacts on ground water quantity and quality associated with each alternative are discussed in the following sections.

EFFECTS OF THE NO ACTION ALTERNATIVE

Due to the advanced stage of the exploration activities a certain degree of disturbance of the original surface and ground water conditions has already taken place. The main impact on the ground water resources would be the continuous discharge from the existing mine. The mine inflow impacts the recharge-discharge characteristics of the ground water system in the mine area. A continuous discharge of the mine water would also have impacts on the surface and ground water quality and quantity in the Sherman Creek drainage.

The present surface disturbance consists of access roads, waste rock storage, water control structures, mine portals, and camp facilities. These facilities do not have any significant impact on the local ground water system, and

after reclamation any potential for impacts would be eliminated.

EFFECTS COMMON TO ALL ACTION ALTERNATIVES

The project components that could potentially impact the ground water system include the waste rock storage, tailings impoundment, embankment construction, and the underground mine workings. Impacts to the ground water system from these components would include changes in the recharge-discharge relationships and potential degradation of ground water quality by seepage from the waste rock storage, tailings disposal, and from accidental spills.

Mine Water

The underground mine drainage causes changes in the ground water flow direction and recharge rates. During and after cessation of the mining activities the ground water in the Kensington Mine area would flow toward the underground workings. The zone of influence of the mine drainage is limited due to the low permeability of the water bearing strata and the steep surficial topography.

During the mining operation the water discharged from the Kensington Mine would be used for the operation, and, therefore, no impacts on ground water quality are anticipated. After cessation of mining the 800 and 2,000 level adits would be sealed to allow most of the underground workings to be flooded. However, plugs sealing the portals would not be designed for the full pre-mining hydrostatic pressure, and water would be allowed to flow from the mine continuously through an installed discharge system. The continuous discharge from the abandoned mine is estimated to range from 200 to 400 gpm, with a seasonal fluctuation within the indicated range.

Flooding of the mine workings would reduce the contact of the sulfide minerals in the ore and waste rock with free oxygen, and, therefore, the potential for acid generation by oxidation would be reduced. The potential for acid generation within the abandoned mine was examined in two ways:

- Analysis of the ore and waste rock samples for acid generating potential. (*See DEIS, Appendix D, Table D4-5, Kensington Soil Materials Chemical and Physical Properties* and *Table D4-6, Kensington Soil Material EP Toxicity Analyses*);

- Examination of the water quality data from the 850 and 2,000 level adits. (*See DEIS, Appendix D, Table D2-8, Selected Ground Water Quality Data, Underground Mine, 850 Foot Level, and Table D2-7, Selected Ground Water Quality Data, Underground Mine, 2,000 Foot Level*).

Eight samples of ore and waste rock were analyzed for acid generation and acid neutralization potential in addition to other chemical parameters, including total and pyritic sulfur. The analyses indicated that the acid generation potential of ore and waste rock is relatively low.

Results of analysis of the fresh and weathered ore and waste rock are presented on *Tables D4-5 and D4-6 (DEIS, Appendix D)*. Laboratory testing of the fresh and weathered ore and waste rock indicated that pyritic sulfur content ranges from less that 0.01 percent to 1.12 percent, organic sulfur content ranges from 0.04 percent to 2.3 percent. The average acid buffering potential from eight samples is -3.4 tons/1,000 tons. According to the U.S. EPA (1978) a material exhibiting a calcium carbonate excess, or a deficiency of less than 5 tons per thousand tons of material, is considered non-toxic. The average acid neutralizing potential from eight samples is 3.2 percent (as $CaCo_3$). All these values indicate the low acid generating potential of the ore and waste rock within the Kensington Mine (SRK, 1989). Results of two additional analyses of ore and waste rock performed in November, 1991 confirmed the results of previous testing. The results of additional analyses are presented in JMM (1992).

The analyses of mine discharge water quality data from both adits indicate that although the median value of sulfates increases from the upper adit value of 16.0 mg/l to 374.5 mg/l at the lower adit, there is no corresponding change in the pH values. This supports the conclusion that little oxidation of material is

occurring. If oxidation were occurring, the sulfur would yield sulfate ions and hydrogen ions which would lead to decreasing pH on the lower level.

Further evidence of limited oxidation and adequate buffering capacity of ore and waste rock disseminated within the mine workings over time is seen in the quality of water discharging from the 800 foot level adit for over 90 years. Water quality of this discharge has been monitored at station number 101 since 1988.

The ore and waste rock testing program, together with mine discharge water quality monitoring, indicates a low potential for acid generation during use and after abandonment of the Kensington Mine.

Waste Rock Storage

All action alternatives consider temporary or permanent waste rock storage within the project area. Percolation of precipitation and snowmelt water through the disposed waste rock could generate impacts on ground water quality. Samples of old and fresh waste rock from the Kensington Mine were tested for parameters which could be leached from the waste rock. Results of the analyses presented in *Table D4-5,* and *Table D4-6 (DEIS Appendix D)*, indicated that the formation of acid conditions in the waste rock disposal and the consequent leachability of trace metals, and the transition metals (Cu, Zn, Cd, Cr, Ni, and Co) in particular, is minimal. This is due to a high pH value of the waste rock (8.0 to 8.1), low content of total sulfur (0.15 to 0.30 percent), and pyritic sulfur (<0.01 to 0.04 percent), and a trace metals content that is below the laboratory detection limits for most metals. Concentrations of barium (0.48 mg/l) and arsenic (0.001 mg/l) are very low and pose no potential for ground water degradation.

Water seepage from the waste rock disposal into the ground water system does not, therefore, present any significant potential for the deterioration of the ground water quality.

Tailings Disposal

All alternatives consider some form of wet or dewatered tailings disposal. Impacts of the tailings disposals on the ground water system can be expressed as potential changes of recharge-discharge characteristics and a possibility of seepage from the tailings disposal into ground water.

The impacts on the recharge-discharge relationship depend on the tailings disposal location and size and on the local hydrologic characteristics. Both potential sites for tailings disposal in the Sherman and Sweeny Creek drainages are located in sections of streams with gaining characteristics, and with low permeable till covering most of the tailings disposal sites. These two factors would limit impacts of the impoundment on the recharge-discharge characteristics. After reclamation the consolidated tailings would have a permeability similar to the in-situ till. The similar permeability of these two types of materials and the construction of the tailings impoundment with drainage systems would facilitate the return of the recharge and ground water flow patterns to premining conditions.

Direct seepage from the tailings impoundment into the ground water system and the subsequent ground water contamination is another potential source of impacts. The Applicant would construct seepage ponds downstream of the tailings embankment to collect seepage. During the life of the operation, the seepage from the tailings impoundment would be collected in the seepage ponds and recycled. The water quality of the seepage would be monitored during the mine operation in order to provide data necessary to evaluate the need for seepage water quality control measures after reclamation.

The Applicant has made certain commitments which should reduce the potential for contamination by seepage. These commitments include the destruction of cyanide prior to disposing the tailings, the diversion of surface runoff flows around the tailings impoundment, the construction and operation of a seepage pond downstream of the tailings embankment, and establishing a ground water

monitoring network downstream of the tailings structure. Long-term impacts would be mitigated by decommissioning and revegetation of the tailings disposal site.

EFFECTS OF ALTERNATIVE B

In this alternative all potential impacts on the ground water system would be limited to the Sherman Creek drainage.

Underground Mine

Although the zone of influence of the underground mine drainage could expand slightly out of the Sherman Creek drainage basin, the impact on other drainage basins would not be significant. The potential impacts of the underground mine on ground water quality and quantity are described in the previous section.

Tailings Disposal

The proposed tailings impoundment in the Sherman Creek drainage would disturb approximately 225 acres. This represents 8.6 percent of the total Sherman Creek drainage area. The proposed tailings pond is located in the lower section of the Sherman Creek drainage. This part of the drainage is covered by low permeability (2.0×10^{-3} to 2.1×10^{-6} ft/day) sediments of the glaciofluvial and glaciolacustrine tills, and the drainage has a gaining character. These two factors would greatly reduce the impacts on the recharge-discharge characteristics of the Sherman Creek ground water system.

The potential seepage rates from the Sherman Creek tailings disposal were calculated by two different methods. Knight and Piesold (1990) used steady state finite element seepage analyses to estimate the seepage rates. This study concluded that less than 10 gpm of seepage would occur through the embankment. The low volume of seepage is due to the methods of the embankment construction, low permeable materials in the impoundment foundation, and an artesian pressure in the bedrock strata underneath the impoundment. The confined conditions underneath the impoundment would act as a counter force to the seepage.

An independent seepage analysis was performed by Hydro-Geo Consultants, Inc. (1991b). In this analysis the computerized version of the McWhorter-Nelson method for determination of seepage in the partially saturated zone beneath the tailings impoundments (McWhorter and Nelson, 1980) was applied. Four different cases representing various scenarios were calculated.

The worst case scenario modeled represents the seepage from the impoundment with the maximum possible pond depth and the highest hydraulic conductivity resulting from testing of the foundation materials and the tailings. The analysis indicated a maximum seepage rate of 35.5 gpm in the first year of the operation from the entire impoundment. In the case of a major storm event occurring when the decant system would not be temporarily functional, the seepage rate could be higher than indicated for a short period of time.

Seepage rates would decrease with time. After 20 years, the seepage rate would decrease to between 2 and 17 gpm and an additional decrease of this seepage rate would occur after reclamation.

The effluent water in the tailings pond would have a pH value of 7.6 and a total cyanide content of 0.01 to 0.07 mg/l.

After the cessation of mining and milling activities the tailings pond would be reclaimed and revegetated. The proposed reclamation plan would reduce the infiltration of precipitation into the tailings and the calculated low seepage rates from the impoundment would be further reduced.

The long term impacts of seepage through the tailings on ground water resources after reclamation of the tailings dam and impoundment were assessed in an analysis by Shangraw (1992). Baseline water quality data indicates that the ground water quality in the Sherman Creek area has high concentrations of trace metals. The modeling discussed in *Chapter 4, Surface Water Hydrology* projected that the tailings pond effluent would have lower concentrations of metals than the ground water.

At the present time the high metal concentrations in ground water do not impact the water quality of Sherman Creek, and it is not anticipated that seepage from the proposed tailings impoundment would degrade water quality. Total cyanide concentrations predicted for ground water are below EPA freshwater fisheries acute and chronic criteria. Impacts to ground and surface water quality from seepage through the tailings after reclamation should not be significant.

EFFECTS OF ALTERNATIVE C

The potential impacts on the ground water hydrology in this alternative would be about the same as discussed in the Alternative B section. The 8.5 miles of access road to Slate Creek Cove would increase the potential for accidental spills. Potential impacts of the accidental spills are addressed in the Surface Water Hydrology Section.

EFFECTS OF ALTERNATIVE D

The ground water impacts from this alternative would be essentially the same as those for Alternative B, except there would be two major watersheds disturbed as a result of the project. Both the Sherman Creek and the Sweeny Creek watersheds would be impacted.

Tailings Disposal

The alternative tailings disposal site in the Sweeny Creek drainage would disturb approximately 135 acres. This area represents 6.5 percent of the total Sweeny Creek drainage basin. The impact on recharge-discharge ground water characteristics would, therefore, not be significant.

The seepage potential and resulting ground water quality from the Sweeny Creek tailings disposal would be about the same as the seepage potential discussed for the Sherman Creek tailings disposal. The geologic and hydrogeologic characteristics of the Sweeny Creek tailings disposal site are considered very similar to the Sherman Creek site where an extensive site exploration has been completed. The smaller size of the impoundment in Sweeny Creek would decrease the seepage potential, however, the higher embankment would tend to increase the hydraulic head in the deposited tailings which would increase the seepage potential. At this time there is no information available about the hydrologic characteristics of the Gastineau Fault, which is known to be aligned with the Sweeny Creek drainage. This fault would require grouting to eliminate potential problems with dam foundation permeability.

The seepage control facilities and monitoring system would be the same for both tailings disposal sites in Sherman and Sweeny Creeks.

EFFECTS OF ALTERNATIVE E

Dewatered tailings containing approximately 14 percent moisture would be disposed on a slope in the northern side of the Sherman Creek drainage (Site A) or on the slope adjacent to Lynn Canal, between Sherman Creek and Sweeny Creek (Site B). The surface disturbance including perimeter ditches and sedimentation pond would amount to about 165 (Site B) or 170 (Site A) acres.

Dewatered Tailings Disposal

This method of disposing processed rock has been applied in several mines worldwide. However, experience with predicting the environmental impacts of this type of tailings disposal is more limited than the experience with the wet tailings disposal.

Seepage analysis and comparison of effluent water quality and existing ground water quality indicate that any impact of the dewatered tailings facility on downstream ground water quality would be non-detectable (Knight and Piesold, Ltd. and SRK, 1991). This is based on the assumption that the geochemical characteristics are similar to those applicable to conventional tailings disposal (Alternatives B, C, D, and F). It is possible that leaching would be more severe in dewatered tailings because rainfall infiltration would occur under unsaturated conditions which could provide additional oxidation potential.

CUMULATIVE EFFECTS

The nearest mining activity to the Kensington Project is the Jualin exploration mine on

Johnson Creek. The Kensington and Jualin mine portals are separated by approximately 2 miles. At this stage of the exploration no cumulative Impacts on ground water are anticipated. The only potential for cumulative impacts on ground water could develop if the underground workings of these two mines would come within a distance of less than 1 mile from each other. In this case the zones of influence developed by drainage of both mines could converge. However, due to the low and directional permeability of the water bearing strata the cones of depression developed by the mine drainages would be steep and, therefore, the cumulative impacts would not be significant. The potential cumulative impacts of the Kensington and Jualin mines on the ground water quality are insignificant because these mines are located in two different ground water drainage basins. Discharge from the Kensington Mine enters the Sherman Creek ground water basin and Lynn Canal, and discharge from the Jualin Mine would enter the Johnson Creek ground water basin and Berners Bay. The Jualin property remains an exploration prospect and it has not been established that there would be a mine development at the Jualin site.

SUMMARY

Water discharge from the underground mine would be collected and pumped to the surface treatment facilities. Quality of the discharged water would be monitored during the entire mining operation. At the time of mine abandonment the portals would be sealed and most of the underground workings would be flooded. This mitigating measure would limit the free oxygen reaction with the potential acid generating minerals disseminated in the mine. A controlled discharge from the mine would prevent a ground water pressure build-up in the flooded mine.

Water quality monitoring programs would be carried out for the life of the project to identify any unforeseen problems which might arise during project operation. Currently established monitoring wells would continue to be sampled. Ground water quality monitoring stations would be maintained below the tailings impoundment. Monitoring plans for the Applicant Proposal are found in Chapter 2. Similar plans would be implemented for all alternatives.

All the action alternatives would have varying degrees of impacts on ground water. The degree of impacts would depend on the number of watersheds affected by each alternative. Ground water quality impacts could be minimized by locating the project in one watershed. Impacts to ground water as a result of development of one of the action alternatives are not expected to be significant.

AQUATIC RESOURCES - MARINE

This section describes the potential impacts of the alternatives on the marine aquatic resources of the area.

EFFECTS OF THE NO ACTION ALTERNATIVE

No additional impacts on marine resources would occur over what would be associated with exploration activities.

EFFECTS COMMON TO ALL ACTION ALTERNATIVES

Potential impacts to marine aquatic resources common to all alternatives fall into three general categories: marine discharges, construction activities, and spills. Aspects of these are described as follows.

Marine Discharges

Disposing excess water would require a wastewater discharge into Lynn Canal. All action alternatives would require a submarine diffuser as part of this wastewater disposal. Addressing the potential impacts requires an assessment of the following points: 1) the estimated distance from the discharge point beyond which adverse biological effects from the wastewater will be non-existent, 2) residency time and associated average wastewater pollutant concentration inside this distance, 3) flushing rate of Lynn Canal and the increase in background concentrations of wastewater constituents, and 4) the transfer of wastewater pollutants to seafloor sediments.

Outfall Options. Two marine outfall deployment depths (50 m and 100 m) are examined in detail as examples of shallow and deep deployment depth. Changing the depth modifies the initial dilution process and hence preliminary diffuser design adjustments are included in the analysis. A 3-port diffuser was analyzed at a 100 m depth and a 12-port diffuser was analyzed at a 50 m depth.

Wastewater Dilution. For purposes of the FEIS, the region within the discharge plume where one or more marine aquatic life standards are not met is referenced to as the mixing zone. Thus the distance from the outfall at which the minimum required dilution is achieved determines its size. This definition differs from those used for other purposes (e.g. the NPDES discharge permit). It is used here because it describes the region of Lynn Canal within which potentially toxic effects to aquatic biota within the water column might occur. Outside this zone all aquatic life water quality criteria are met, and no impacts would be expected.

Wastewater quality is discussed under *Surface Water Hydrology*, Chapter 4. The projected wastewater quality was compared with aquatic life standards to determine dilution needs. *Table 4-14, Minimum Wastewater Dilution Required to Meet Receiving Water Quality Standards*, shows needed dilution ratios (i.e. the seawater to wastewater mixing ratios) for each wastewater treatment option. The controlling constituent is total suspended solids for Alternative B and Alternative F, Options 1 and 3. The dilution ratio needed is 88:1 (i.e. 88 parts seawater to 1 part wastewater). Total cyanide, with a needed dilution ratio of 29:1, determines the dilution requirements for Alternative F, Option 2.

An assessment of marine discharges requires an understanding of the way wastewater pollutants would mix in Lynn Canal receiving waters. On initial release the fresh (i.e. buoyant) wastewater rises through the water column and draws surrounding ambient water into its flow, which dilutes the plume. The process continues until the plume is sufficiently diluted with seawater to render the plume neutrally buoyant. At this point the mixture of wastewater and sea water becomes a passive element in Lynn Canal receiving waters. It continues to be dispersed over larger and larger areas until eventually it adds to the background chemical constituents in the sea.

The wastewater dilution which takes place during the buoyant plume rise phase (initial dilution) is a simple process to understand. It is more easily and accurately predicted than the dilution processes that take place afterwards. Further, it is typically more energetic and results in a greater amount of dilution over a shorter distance than does the secondary dilution which follows.

The dominance of the initial dilution process in the vicinity of the discharge point is an important feature since it allows the design of the wastewater outfall to determine, in large measure, the minimum amount of dilution that the wastewater will experience and at what distance from the discharge point (Kessler and Vigers, 1992). Dilution provides an effective wastewater management strategy only insofar as the required dilution occurs sufficiently near the outfall, the flushing of the receiving waters is rapid enough and particle deposition and bio-accumulation effects are not significant.

The most constraining case for diffuser design is a required dilution ratio of 88:1, and this is treated as the worst-case minimum dilution in the ensuing discussion.

The various diffuser design options were examined using standard EPA computer simulation models to test whether the necessary worst-case minimum dilution requirement in *Table 4-14, Minimum Waste Water Dilution Required to Meet Receiving Water Quality Standards*, could be achieved and at what distance from the point of discharge.

Meeting a minimum dilution is only one of several design criterion. These related criteria are optimal size, shape, and trapping depth of the buoyant discharge plume. The latter is the depth at which the plume ceases to rise. Unfortunately, all these criteria are interrelated and, as design goals, are not necessarily complementary. Maximizing achieved dilution minimizes trapping depth; both put constraints on the size and shape of the plume.

Table 4-14, Minimum Wastewater Dilution Required to Meet Receiving Water Quality Standards

Wastewater Parameter	Required Minimum Dilution			
	Alternative B	Alternative F Option 1	Alternative F Option 2	Alternative F Option 3
Arsenic	0:1	0:1	0:1	0:1
Cadmium	0:1	0:1	0:1	0:1
Chromium	0:1	0:1	0:1	0:1
Copper	26:1	38:1	22:1	10:1
Lead	13:1	14:1	0.4:1	4.6:1
Nickel	3.5:1	3.7:1	2:0	1.1:1
Selenium	2.7:1	2.8:1	1.4:1	0.5:1
Zinc	0:1	0:1	0:1	0:1
Mercury	--[1]	--[1]	--[1]	--[1]
Cyanide	68:1	30:1	29:1	23:1
Solids	88:1[2]	79:1	7.1:1	88:1[2]
Controlling Dilution	88:1	79:1	29:1	88:1

[1]Wastewater concentration below analytical detection limit.
[2]Based on State imposed limit of 10 percent decrease in water clarity and assumes that the discharge meets NSPS at end-of-pipe.

For the purposes of the FEIS analysis the design criteria were as follows:

- Maximize dilution in initial mixing zone to insure water quality standards are met.
- Insure that the rising plume does not enter the photic zone (upper 20 m of water column).
- **3-port Diffuser Mixing Zone (100 m Depth Deployment)**

  The volume of the worst-case mixing zone (i.e. defined by a 88:1 dilution ratio) for this diffuser configuration ranges from 261 to 1,143 cubic meters, depending on time of year and the wastewater discharge rate. The mean depth of the mixing zone is a measure of how it is distributed in the water column, and is calculated to range from 89 to 90 m (i.e. about 10 m off the seafloor in all cases, with the corresponding upper edge about 15 m off the seafloor). The total exposure times that a planktonic organism would be entrained in the mixing zone ranges from 70 to 89 seconds. This information is shown on *Table 4-15, Mixing Zone Characteristics Depending on Diffuser Type*. The table shows how the mixing zone for all diffuser configurations considered would vary in size in relation to flow rate and time of year.

- **12-port Diffuser Mixing Zone (50 m Depth Deployment)**

  The worst-case mixing zone for this diffuser configuration ranges in volume from 176 to 267 cubic meters, and is located at an average depth for 47 to 49 m (i.e. 1 to 3 m off the seafloor, with the upper edge about 6 m off the seafloor). Planktonic residence

times in the mixing zone range from 35 to 51 seconds (*See Table 4-15, Mixing Zone Characteristics Depending on Diffuser Type*).

Table 4-15, Mixing Zone Characteristics Depending on Diffuser Type

Diffuser Type	Discharge Flow (gpm)	Mixing Zone Volume[1] (m^3)	Mean Depth (m)	Total Exposure (Seconds)
100 m DEPTH DEPLOYMENT September Density Profile				
3-port	1,500	288	90	74
3-port	2,500	528	89	82
3-port	5,000	1,143	89	89
April Density Profile				
3-port	1,500	261	90	70
3-port	2,500	474	90	76
3-port	5,000	1,020	90	82
50 m DEPTH DEPLOYMENT September Density Profile				
12-port	1,500	193	47	51
12-port	2,500	267	47	49
12-port	5,000	213	49	36
April Density Profile				
12-port	1,500	176	47	47
12-port	2,500	255	47	46
12-port	5,000	219	49	35

[1]Calculated to point where dilution satisfies minimum dilution ratio required of 88:1.

- **Diffuser Effectiveness in Meeting Design Objectives**

The effectiveness of a diffuser configuration would be judged by its ability to meet the minimum dilution and photic zone requirements.

Both diffuser configurations (i.e. the 3-port diffuser at 100 m and the 12-port diffuser at 50 m) meet the required minimum dilution ratio of 88:1 and the minimum plume trapping depth of 20 m. The trapping depth requirement is best met by the 3-port diffuser at 100 m, and the minimum dilution requirement is best met by the 12-port diffuser at 50 m.

Lynn Canal Pollutant Loading. The impact of the submarine wastewater discharge also requires an analysis of pollutant loading effects.

On the basis of currents measured off Point Sherman, the maximum residence time (i.e. flushing period) of water in Lynn Canal is estimated to be 20 days. The total mass of a wastewater constituent discharged over this period in combination with the estimated volume of water in Lynn Canal can be used to calculate the maximum increase in background concentrations expected over the life of the project (Kessler and Vigers, 1992).

The effect of wastewater loadings is presented only for copper, lead, and total cyanide since these are the wastewater pollutants of greatest interest. The results are not materially different for the other wastewater components (Kessler and Vigers, 1992).

The loading effects on Lynn Canal from alternatives and different treatment options are presented in *Table 4-16, Lynn Canal Pollutant Loadings, 20 Day Flushing Periods*. The table shows that maximum background concentrations of all three wastewater constituents in Lynn Canal would be expected to rise less than 1 part per trillion and would not be measurable.

Table 4-16, Lynn Canal Pollutant Loadings, 20 Day Flushing Periods

Pollutant	Lynn Canal Background	Alterntive B	
	ppt	kg[1]	ppt[2]
Copper	430	59	0.9
Lead	109	32	0.5
Cyanide	-	19	0.3

[1]Total pollutant discharge to Lynn Canal in a 20 day period (kilograms)
[2]Maximum increase in Lynn Canal background concentration (parts per trillion)

Wastewater Particulates and Deposition. Because suspended particles in the effluent discharge would tend to settle out, the deposition pattern in Lynn Canal was estimated. The analysis was based on a specifically developed secondary dilution and particle deposition simulation model that is described in Kessler and Vigers (1992).

Alternative B and Alternative F, option 1 represent the high-end of the range of expected sedimentation effects on Lynn Canal for the various wastewater constituents. The estimated annual average increase in water column total suspended solids ranges from 21 mg/m^3 within 25 m of the outfall to 1 mg/m^3 at 3 km distance, representing TSS increases in Lynn Canal of 2.4 percent and 0.1 percent respectively. It is estimated that this would decrease water clarity in the affected area by less than 2 percent (Kessler and Vigers, 1992), which is less than the State limit of 10 percent. The low-end increase in water column total suspended solids (i.e. Alternative F) is estimated to decrease water clarity (in the immediate vicinity of the outfall) by 0.4, less than 0.1 and 0.4 percent for Options 1, 2 and 3 respectively.

Yearly total solids deposition predicted on the basis of the modeled high-end total suspended solids distribution, ranges from 8.5 gm/m^2 within 25 m of the outfall to 1 gm/m^2 at 1 km distance. This represents increments of 3 percent and 0.4 percent compared to the existing background deposition rate.

Based on projected wastewater heavy metal concentrations for Alternative B, the estimated increment in TSS deposition summarized above would, over the life of the project, result in seabed copper concentration increasing from 40 mg/kg to 49.2 mg/kg (an increase of 9.2 mg/kg or 23 percent) within 25 m of the outfall, with the increase declining to 0.6 mg/kg or 1.5 percent at 1 km distance from the outfall. This falls within the measured existing variability of 15 percent (i.e. 38 to 44 mg/kg) (Kessler and Vigers, 1992). Similar percent increases, below or comparable to existing variability in seabed chemistry, were predicted for all other wastewater constituents, except lead.

For Alternative B and Alternative F, option 1, lead is predicted to increase by 9.1 mg/kg (i.e. 12 to 21.1 mg/kg) within 25 m of the outfall, with the increase declining to 0.2 mg/kg by 1 km distance. While the 74 percent increase 25 m from the outfall exceeds the natural variability of 33 percent, this must be viewed in the context of the strong bias towards impact over-estimation built into the model calculations (Kessler and Vigers, 1992).

Wastewater lead concentration is predicted to be lower for Alternative F, Option 2 and 3. As a consequence, the increase in sediment lead concentration within 25 m of the outfall is predicted to be 1 mg/kg (or less than 1 percent) for Option 2 and 4.3 mg/kg (or 36 percent) for Option 3 (Kessler and Vigers, 1992).

Marine Discharges Summary. The most important conclusion regarding diffuser performance is, that within the range of projected effluent flows and effluent quality, an effective diffuser can be designed that would meet the minimum dilution requirement for all alternatives with outfall depths ranging from 50 m to 100 m. Moreover, the discharge plume

can be kept below the photic zone and the associated mixing zone would be small.

The main conclusion of the Lynn Canal loading and secondary dilution assessment is that average wastewater constituent concentrations in Lynn Canal waters outside the mixing zone would not be measurable above existing background levels. Due to its effect on water clarity, the increase in total suspended solids predicted for Alternative B near the outfall, could be detectable compared to the no action alternative, however the decrease would be well within Alaska standards.

The main conclusion of the seabed deposition assessment is that the increase in particle deposition rate associated with the discharge would not be measurable above existing background levels.

Finally, the increase in wastewater constituent concentrations in the bottom sediments over the life of the project would be less than the measured range of existing natural variability.

Impacts of Total Suspended Solids. Suspended solids (TSS) occur naturally in aquatic environments, easily seen in waters in and around Lynn Canal. Coastal marine organisms, like those inhabiting Lynn Canal, have adapted to survive under a range of TSS concentrations. Many of these animals encounter significant natural variation in suspended sediment conditions during their lives.

High enough concentrations continuing for long enough periods, however, can inhibit essential biological functions such as respiration, feeding, and photosynthesis (EPA, 1972; Peterson et al., 1985). In particularly severe situations, these functions can be completely blocked, as can occur for benthic organisms by being smothered by excessive deposition (Kessler and Vigers, 1992). This latter case could also result in either short or long-term changes to bottom habitat.

Marine species have been found to suffer adverse effects due to TSS beginning over a wide range of concentrations. Those organisms most tolerant of increases in sediment loads tend to be those associated with silt bottoms or those in or associated with estuarine habitat; tolerances as high as 4,000 mg/l have been reported (EPA, 1972). In an extensive review of information related to Alaska's particulates criteria, Peterson et al. (1985) concluded that no mortalities could be cited for marine organisms at TSS levels less than 100 mg/l. The only negative effect cited at low concentrations was on the feeding rate of larval herring, which was reduced at 20 mg/l of suspended silt (Kiorboe et al., 1981). Conversely, the blue mussel apparently benefitted from concentrations up to 25 mg/l (Kiorboe et al., 1980).

The proposed project's effluent would be limited under an NPDES permit to average monthly concentrations of TSS of 20 mg/l, with daily maximum levels not to exceed 30 mg/l. These concentrations, posing minimal risks at the outfall, would be reduced still further by the mixing process described earlier. No adverse effects would occur to planktonic and free swimming organisms.

Since changes in deposition rates compared to ambient conditions are predicted to be undetectable (see above), no impacts to benthic communities are projected.

Impacts of Heavy Metals. Heavy metals occur naturally in substrate, water, and biota in marine environments. Bottom sediments and natural runoff provide continuous sources of heavy metals to the marine ecosystem.

Some metals are essential to aquatic animals in small amounts (e.g., copper, zinc, iron and cobalt), while others apparently serve no useful purpose (Forstner and Wittman, 1981). Aquatic organisms can assimilate metals by ingestion of particulate material suspended in water, ingestion of food, ion exchange, and adsorption on tissue and membrane surfaces (Phillips and Russo, 1978).

Heavy metals can have acute or chronic toxic effects on aquatic organisms, depending on concentrations and organisms involved (Leland and Kuwabars, 1985; Mance, 1987). Acute effects occur rapidly, are generally severe, and may be lethal. Chronic effects can occur as changes in behavior, reproduction, or physiology.

In particular, metals pose long-term risks because of their tendency to be bioaccumulated in various tissues. Extended periods of bioaccumulation can damage organisms, resulting in reduced survival or reproductive success (Mance, 1987). Metals also pose risks of altering movements and habitat selection of animals through either avoidance or attraction.

Exposures and associated risks experienced by aquatic organisms to heavy metals discharged by a project like Kensington differ among species and are dependent upon an organism's life history, behavior, feeding strategy, age, and ability to metabolize and eliminate contaminants (Forstner and Wittman, 1981). These factors affect the probability of encountering elevated metals levels, the duration of exposure, and how readily a substance is taken into an animal and retained.

The initial opportunity for metals discharged from the proposed outfall to be encountered by the biota would be by free-swimming and passively drifting organisms within the water column. The probability of encountering elevated metals levels by such organisms passing through the project area would be largely a function of the volume of water containing those levels compared to the available area being utilized.

The sizes of mixing zones associated with the range of outfall options described for the proposed project are very small compared to the available area (*See Table 4-15, Mixing Zone Characteristics Depending on Diffuser Type*). The worst case scenario for these outfall configurations results in a mixing zone of about 1,100 cu. m, which could hypothetically be contained by a cube of slightly over 10 meters on each side. The mixing zone associated with all configurations would remain restricted to the lower depths.

While the probability of encountering such a small mixing zone would be relatively small for all species, it would not be equal for all species. As shown in *Figure 3-16* (*Generalized Summer Distribution of Major Pelagic Fish Within Lynn Canal*), the large majority of migrating juvenile and adult salmon would not be expected to encounter the zone at all because of their preferred shallow depths in the water column.

A higher probability would exist for immature chinook salmon feeding in Lynn Canal, but compared to their available habitat in the area, the probability of encounter would still be very small. The probability of encounter would also be higher for herring, Pacific cod, walleye pollock, and sablefish than for juvenile and adult salmon. Still it would be small because of the small zone compared to the body of water available. There is no reason to expect that any of these species prefer the waters in the vicinity of the proposed outfall more than in other similar areas in the canal.

Free-swimming or passively drifting organisms encountering elevated metals concentrations in the proximity of the proposed outfall still would be at relatively low risk of being harmed due to the likelihood for a short exposure time. A planktonic organism entrained in the plume at the outfall would rise with the water in the plume as it is moved upwards due to buoyancy effects. The worst case maximum exposure to concentrations exceeding water quality criteria for such an animal would be approximately 1.5 minutes (*See Table 4-15, Mixing Zone Characteristics Depending on Diffuser Type*). It is important to note that potentially lethal concentrations of pollutants in the effluent based on 96 hours of exposure would occur much closer to the outfall than the point of achieving water quality criteria. Maximum time spent in this area would be substantially less than the 1.5 minutes.

Free-swimming animals would not be expected to reside for extended periods within the zone containing concentrations exceeding water quality criteria. These animals are known to move with their prey, in response to currents, or associated with directed migrations (See *Chapter 3, Aquatic Resources - Marine*). The probability of remaining within the worst case volume of approximately 1,100 cubic meters long enough to suffer chronic effects would be extremely small. The probability for lethal effects would be nil.

These expectations also apply when considering the potential for additive effects of different constituents in the discharge. It is known that the toxicities of some metals are additive at certain concentrations, as is the case when copper and zinc occur together (Sprague and

Ramsay, 1965). By adding the toxicities (expressed as toxic units) of those metals whose concentrations are projected to be above detection limits in the Kensington effluent, the estimated combined toxicity would be less than one toxic unit at the point where water quality criteria are reached for all constituents. A toxic unit for a particular constituent is defined as the lowest reported concentration having toxic effects.

In considering the constituents together, not all of the substances have additive effects. The toxicities of cyanide and metals are not simply additive due primarily to the formation of metallocyanides with some metals. Iron cyanides, for example, are expected to comprise a significant amount of the total cyanide in the discharge, yet this substance is both relatively stable and of low toxicity (Doudoroff, 1976). Iron cyanides discharged at a relatively deep depth, as proposed for Lynn Canal, would not be expected to undergo any photodegradation, which can cause a release of free cyanide. When considering these types of metal cyanide interactions, it is very likely that the result would be less than additive in the case of the Kensington discharge.

Bottom sediments typically act as a sink for heavy metals being discharged to the aquatic environment. Hence benthic organisms and demersal fishes with benthic habits, i.e., the flounders (Pleuronectidae), within the affected area could have a greater potential for being affected by metals than pelagic or planktonic forms (Kessler and Vigers, 1992). Most metals discharged to a marine environment often become associated with the bottom sediments fairly rapidly both through precipitation and deposition of particles upon which metal ions are adsorbed (Forstner and Wittman, 1981). Organisms associated with sediments have an increased potential to accumulate metals in their tissues than do organisms residing high in the water column (Phillips and Russo, 1978).

The extent of a benthic or demersal organism's mobility has a significant effect on its susceptibility to heavy metals (Forstner and Wittman, 1981). Movement, whether random or directed as part of a migration, would determine the length of exposure to elevated metals in sediment within a particular area. Bottomfish usually move considerable distances during their lives, and levels of contaminants within their tissues generally reflect conditions over a wider geographical area than for sediments at particular sites (Varanasi et al., 1989). Such movements would preclude significant effects on these species from the proposed marine discharge.

This is illustrated in data reported by Varanasi et al. (1989) for flathead sole in Alaskan waters, including Lynn Canal. As part of the National Benthic Surveillance Project, they reported relatively high levels of selenium within sediments at some sites in Alaska, including areas of Lynn Canal, although livers of flathead sole at these locations had low concentrations. Conversely, high amounts of arsenic were found in flathead sole livers at some sites, including Lynn Canal, yet sediment concentrations were low. Sources of these metals were believed to be unrelated to human influences (Varanasi et al., 1989; McCain, 1990). Similar conclusions were drawn in evaluating elevated arsenic and antimony levels in fish tissues in Lutak Inlet and Nahku Bay at the head of Lynn Canal (ADEC, 1990).

Given projections of negligible increases in metals concentrations in sediment near the outfall combined with species movement patterns, no bioaccumulation in demersal fishes as a result of this project is expected (Kessler and Vigers, 1992). For comparison, bioaccumulation in demersal fish could not be documented with certainty in Skagway Harbor (head of Lynn Canal) where increases in metals in sediments were increased by 25,000 percent over uncontaminated areas (Robinson-Wilson and Malinkey, in press; Tetra Tech, 1990a). Concentrations of lead, zinc, copper, cadmium, and mercury were all significantly higher in sediments within the ore loading basin than in nearby Nahku Bay, which served as a control. Lead and zinc concentrations were particularly high, exceeding levels found at marine sludge disposal sites in the New York Bight. Lead levels were greater than the highest concentrations found in contaminated areas in Southern California as reported by Segar and Davis (1984).

Crab and shrimp can potentially accumulate metals because of their close association with

marine sediments. No bioaccumulation is expected for these species, however, because of negligible Increases in metals predicted (See discussion above). Their mobility combined with loss of accumulated metals through molting generally provide additional safeguards against excessive buildup (Guthrie et al., 1979; Phillips, 1990). Major species of crab and shrimp In the project vicinity all are known to have substantial movements, with the possible exception of coonstripe shrimp (See discussion on movements of shellfish in *Chapter 3*).

Sedentary animals are typically at greatest risk of being impacted by discharges of heavy metals to the marine environment (Mance, 1987). However, projections for negligible increases in metal levels in sediments in the vicinity of the outfall indicate that effects on sedentary animals in this area would be minor. The infauna In this general area consists predominantly of polychaete worms. Animals further removed from the outfall, such as blue mussels in the intertidal area would also be at no risk to bioaccumulation.

Notwithstanding the minimal risks posed to sedentary animals in the project area, an NPDES permit would require bioaccumulation monitoring for indicator species *(See Appendix D, Draft NPDES Permit).*

An additional area of concern related to discharging heavy metals into the marine environment is the potential for biomagnification of metals through the food chain (Mance, 1987). This phenomenon refers to the process of transferring contaminants via ingestion through the food chain with progressively greater metal concentrations occurring at each higher tropic level. Highest concentrations would occur in the top carnivores, potentially humans.

Due to the absence of bioaccumulation predicted from the proposed project, the risk of biomagnification is expected to be nil (Kessler and Vigers, 1992). It is noteworthy also that biomagnification does not commonly occur for metals, even in cases of known bioaccumulation (OTA, 1987, Mance, 1987). Mercury and arsenic are the only two metals known to biomagnify, due likely to their high affinity to organic substances (Mance, 1987).

EPA (1986) listed arsenic as a carcinogen, but elevations in concentrations of this element are expected to be minute and, therefore, pose minimal risks. Lead was recently classified by EPA as carcinogenic to animals and also likely to humans, via oral exposure (EPA, 1990). Because the potential carcinogenicity for lead is low (Tetra Tech, 1990b) and concentrations projected for this project are low, potential risks would be negligible.

The National Institute of Occupational Safety and Health Pocket Guide to Chemical Hazards (1987) recommended that several other metals be considered as carcinogenic to humans: cadmium, chromium and nickel. Bioaccumulation potential of these metals is expected to be so low from the proposed project, as to warrant an inconsequential risk to marine animals and humans.

Another potential impact of discharging dissolved metals into the aquatic environment is avoidance of the affected area by some species. Such effects could restrict use of important habitats or diminish the availability of fish to fisheries in specific areas. Salmonid species have been found to generally avoid areas of elevated metal concentrations when given a choice to do so, though limited studies on the various metals have been conducted (Giattina and Garton, 1983). Salmonids appear to be attracted by low concentrations of at least one metal, mercury.

Under laboratory conditions, salmonids are most sensitive to low copper levels, being able to detect and avoid concentrations as low as the water quality criterion for marine aquatic life (0.0029 mg/l)(Giattina and Garton, 1983). Detectable limits for other metals were generally much higher than water quality criteria. Giattina and Garton (1983) concluded, however, that copper levels causing avoidance in the natural environment were likely higher than levels measured under laboratory conditions.

Sprague et al. (1965) and Saunders and Sprague (1967), evaluating effects of mine discharges on the migration of adult Atlantic salmon (*Salmo salar*) in a river system, reported that avoidance began with a combined concentration of approximately 0.02 mg/l copper and 0.2 mg/l zinc. Migration ceased at

levels approximately twice those concentrations. Toxic effects of these metals combined are known to be additive within these ranges (Sprague and Ramsay, 1965). Therefore, the effect of either element alone in the concentrations shown would likely have been less.

These studies suggest that avoidance of the immediate vicinity of the proposed outfall could occur by salmonid species. Natural copper levels existing in at least some streams entering Lynn Canal, however, demonstrate that salmon migrations would be unaffected by concentrations substantially higher than for laboratory studies reported by Giattina and Garton (1983). Ambient copper concentrations in Sherman and Sweeny creeks, for example (*See DEIS Appendix D2, Surface and Groundwater Quality Data*), sometimes exceed levels causing avoidance under laboratory conditions. Concentrations were found in some instances to exceed levels causing avoidance in the natural environment reported by Sprague et al. (1965). Copper concentrations in these streams appear to commonly exceed the marine water quality criterion for this element. Salmon homing to these streams, as well as use of the nearshore environment in the vicinity of the mouths of these streams by juveniles, indicates no avoidance to these ambient conditions.

If salmon species can detect the effluent and choose to avoid the immediate vicinity of the outfall, effects on migrations would be negligible. The migration paths of adult and juvenile salmon through the area proposed is shallow compared to the depth of the outfall and its associated mixing zone. Migration through the area would remain unaffected. No impacts are expected to salmon fisheries due to avoidance as a result of implementing any of the alternatives.

Impacts of Cyanides. The proposed discharge would include low levels of cyanides, particularly those forms complexed with metals. Three forms of cyanide can persist following the cyanide destruction process. The most prevalent forms are generally weakly bound metal cyanide complexes (WAD cyanide) or strongly bound complexes with iron (expressed within measurements of total cyanide). Free cyanide (both hydrogen cyanide and the cyanide ion) is typically reduced to extremely low levels with single stage cyanide destruction (Palmer et al., 1988) followed with shallow pond detention.

Measurements of WAD cyanide would report all forms of cyanide except cyanide bound to iron, which is reported as a part of total cyanide. Cyanides toxic to aquatic organisms are the free and WAD forms, while no toxicity is generally attributed directly to iron cyanides (Doudoroff, 1976).

Acute cyanide toxicity occurs as the result of an inhibition of oxygen metabolism, which renders tissue incapable of exchanging oxygen (Leduc et al., 1982). Bioaccumulation does not occur for cyanide. The effect of cyanide is rapid in high enough concentrations, but reversible. Fish overcome by cyanide will revive with no apparent ill effects if removed soon enough from the area of contamination (Leduc et al., 1982).

Free cyanide is rapidly lethal at high enough concentrations. Lethal concentrations for aquatic organisms (96 hour LC50s, i.e., those concentrations producing 50 percent mortality) range from 0.005 to greater than 10.00 mg/l hydrogen cyanide (EPA, 1986). For marine species, invertebrates have been observed to be the most and least sensitive of all organisms tested (EPA, 1986).

The highest concentrations of total cyanide (of which free cyanide is a part) for the proposed project are projected to be approximately 0.069 mg/l at the point of discharge. This amount is 14 times the lower end of the range reported for LC50s. When diluted by the plume dispersal process to the point of achieving the water quality criterion a short distance away, the concentration would be approximately 10 percent of the lower end of the observed lethal range.

Concentrations of total cyanide in the discharge would meet the water quality criterion within a short distance of the outfall as described previously. The worst case dilution requirement for cyanide would be associated with a mixing zone somewhat less than 1,100 cubic meters in size. As described for heavy metals, organisms

would be exposed to concentrations greater than the criterion only very briefly. No lethal or chronic effects to organisms passing through the effluent plume are expected.

Iron cyanide, included in measurements of total cyanide, would also be present in the proposed discharge. The iron cyanide complex is non-toxic and exhibits toxicity only through its breakdown to form WAD or free cyanide, which can occur in the presence of light (Doudoroff, 1976) or through bacterial decomposition in rare situations (Cherryholmes et al., 1985). However, the rate of breakdown of iron cyanide at the depths of discharge being considered is expected to be negligible (Mudder, 1990).

Other compounds related to cyanide would be formed in the milling and treatment processes being proposed. These include cyanate, thiocyanate, and cyanogen chloride. Of these, cyanogen chloride alone poses a potential for high toxicity (JMM, 1992), but in the presence of excess chlorine breaks down very rapidly to form cyanate. It has not been reported as an environmental problem at the numerous installations utilizing alkaline chlorination (JMM, 1992).

Impacts of Other Effluent Constituents. The effluent will contain other compounds resulting from the milling and treatment process.

Residual free chlorine could be present in some alternatives and can be highly toxic to aquatic life depending on concentrations (EPA, 1986). LC50s for marine species have been reported in to be in the range of 0.026 to 1.400 mg/l. The water quality criterion for free chlorine is 0.002 mg/l. The worst case projected level of free chlorine in the effluent without dechlorination would achieve the water quality criterion within a mixing zone of the same size needed to meet criteria for other constituents. Impacts from chlorine are not expected.

Some amount of un-ionized ammonia is expected to be present in the discharge. Ammonia is the final degradation product of the cyanide treatment process proposed by the Applicant. No marine water criteria have been adopted by regulatory agencies for ammonia in the marine environment and ammonia discharged at the expected level is not considered problematic (JMM, 1992).

At the discharge level projected for total ammonia, only about 2 percent would occur in the un-ionized form (given expected temperatures and pH of the receiving waters). The un-ionized form is the only known form of the compound toxic to aquatic organisms. This results in a projected level at the outfall of less than 0.04 mg/l of un-ionized ammonia. LC50s have been reported to be as low as 0.04 mg/l of the un-ionized form for salmon species in saltwater (EPA, 1984). This constituent, however, would be rendered harmless within a short distance of the outfall.

Physical Interference With Fishery. The outfall would be located within an area where commercial fishing has historically occurred. However, because of the depth of the outfall, no interference with gillnets should occur. No other forms of fishing gear are expected to encounter interference in this area.

Some form of routine monitoring would likely be required to ensure that anchor fouling, which could potentially occur, does not damage the pipeline. Should the pipeline be ruptured, the diffuser would not operate as designed.

Construction Activities and Facilities

Excavation of a temporary barge landing site would be necessary at Comet Beach. Disturbances would have short term effects on intertidal community within the immediate area of excavation. Impacts due to excavation and siltation are expected to be negligible.

Two mooring dolfins would be installed for fuel offloading. These structures may impact the ability of gillnet fishers to efficiently fish the immediate area.

Spills

Hazardous substances would be used on a routine basis at the project site during construction and mine operation. These materials consist of fuels, both diesel and LPG, and chemical reagents to be used in the milling process. Spills of these substances entering

Lynn Canal could adversely impact the marine biota.

Fuel spills could occur from a major accident, such as a vessel collision, sinking, or grounding or during transfer operations. The fuel of concern to the marine environment would be diesel. The extreme volatility of LPG and its rapid vaporization prevent this substance from being a pollution threat to the aquatic environment.

Diesel fuel would be shipped to the project site by tanker, such as the one that now serves the site as well as other points further north along Lynn Canal. Exploration activities at the mine site currently require diesel shipments approximately every 2 weeks with an average of 30,000 gallons per delivery. Frequency of transfers would be increased to about once weekly during construction, but would return to an average of once every other week during mine operations. Thus the risk of a vessel accident during the mining phase would be no greater than it is currently, though it would increase during construction. Diesel deliveries would increase to about 80,000 gallons per delivery during the operational phase.

The secure passage of fuel oil through Lynn Canal to the project site would be the responsibility of the shipper, who is regulated through existing federal and State statutes. The tanker currently servicing the Kensington site is 240 feet in length with a holding capacity of 1.1 million gallons. The shipper would be responsible for any spills during shipping and transfer to the site; cleanup measures would be under the direction of the U.S. Coast Guard and the ADEC.

Incidents of oil pollution in Lynn Canal are relatively few despite the amount of vessel traffic. (*See Table 4-17, Number and Type of Oil Pollution Events in Lynn Canal, 1986-1990*). For a discussion of the amount of vessel traffic in Lynn Canal, (*See Transportation, Chapter 4*). The probability of a major spill in Lynn Canal would not be appreciably increased as a result of fuel shipments to the site.

The most likely source of fuel spills in Lynn Canal resulting from this project would occur during transfer operations, either from the supply vessel to the facility or via Sherman Creek from spills in that drainage. Such spills can occur from faulty valves, poor pipe connections, and contaminated deck drainage from vessels (ADF&G, 1979). A faulty valve at the project site was the cause of diesel spill in 1990, which resulted in up to 100 gallons entering Lynn Canal via Sherman Creek. Although new procedures have been implemented to prevent such spills, the potential remains for these types of events. The applicant would be required to have an approved Spill Prevention Control Countermeasure Plan for the project.

Should a spill occur in Lynn Canal as a result of the proposed activities, its dispersion would be affected by a variety of factors, including its size, tidal effects, bathymetric and topographic features, wind, freshwater runoff into the canal, and the speed and effectiveness of spill response actions (ADF&G, 1979; WDF, 1982). These factors would largely determine the longevity of the spill and its associated biological effects. A major spill resulting from a vessel collision or grounding in Lynn Canal could become widely distributed before clean up actions could respond (ADF&G, 1979).

Table 4-17, Number and Type of Oil Pollution Events in Lynn Canal, 1986 - 1990

Cause of Spill	Number of Events	Quantity per Event	Type
Vessel sinkings[1]	2	<200 gallons	NA
Cruise ship	1	30 gallons	Bunker
Facility[2]	1	<100 gallons	Diesel
Mystery cases[3]	9	<1 gallon	Unknow

Source: U.S. Coast Guard, 1991
[1]Small fishing vessels.
[2]Spill of 2,500 gallons occurred at Kensington Mine, of which less than 100 gallons entered Lynn Canal.
[3]Reports given by aircraft; likely result of bilge pumping.

Compared to the heavier crude oils, diesel is considered a non-persistent petroleum product similar to other lighter refined products such as gasoline and kerosene. Although these products are highly toxic, their residency times in the marine environment is relatively short compared to the heavier oils (Clark and MacLeod, 1977). The large majority of diesel oil hydrocarbons readily evaporates (National Academy of Sciences, 1975), particularly in conditions of rough seas. In this situation, evaporation rates are increased because sea spray and bursting bubbles eject the hydrocarbons into the atmosphere (Clark and MacLeod, 1977).

However, when diesel spills are in the immediate proximity of a beach, the oil can become trapped in the sediments and remain for several years (Gulliksen and Taasen, 1982; Keceniuk and Williams, 1987). This trapping of diesel fuel in beach sediments associated with a slow release to the water column has been observed even on high energy beaches (McLaren, 1985).

The lighter non-persistent oils such as diesel are generally more toxic than heavier oils because of their high concentrations of aromatic compounds. These can become mixed in the water column, which then can cause lethal and sub-lethal toxic effects to marine organisms (Rice et al. 1975; ADF&G, 1979). Diesel trapped in beach sediments can continue to be lethal to intertidal organisms in the immediate vicinity of the oil for months (Gulliksen and Taasen, 1982).

In contrast, lethal toxicities to fish such as migrant salmon juveniles would be short term (Bax, 1987), unless a spill occurred during late April to early June when pink and chum salmon fry are closely associated with the foreshore. Findings of Archipelago Marine Research, Ltd. (1991) suggest that a spill impacting the foreshore of beaches being utilized by newly emerged pink and chum fry could be highly detrimental to fish present at those sites. In such a case, effects would be prolonged, perhaps for several weeks. Impacts to migrant salmonids not dependent on the foreshore, i.e. larger than newly emerged fish, would be lessened somewhat by the likelihood of avoidance reactions to a spill (Bax, 1987).

The impacts of reasonable worst case scenarios for diesel spills within Lynn Canal would vary by species. In the event of a tanker collision or grounding, a large percentage of the ship's supplies could be lost. This would likely be significantly less than the holding capacity of the tanker serving the canal (1.1 million gallons) but greater than the projected delivery amount to the Kensington Mine (80,000 gallons). If such a spill occurred during the outmigration of juvenile salmon, mortalities would likely be negligible to the populations on the whole moving through the area, i.e. less than 1 percent (Bax, 1987). Impacts to subsequent fisheries would be undetectable.

If such an event occurred during the salmon fishery, tainting of some fish would be expected. Although the percentages of the total populations affected would be small (Bax, 1987), the stigma of potential tainting could have significant effects to the fishery as a whole (Baker et al., 1990). Tainting of other species could occur as well, e.g. cod and flatfish. Two months following a spill of about 450,000 gallons of diesel in northern Norway, the flesh of these species remained tainted even though no hydrocarbons were detectable within water and sediment samples (Palmork and Wilhelmsen, 1974).

A major spill due to a vessel accident or through ship to shore transfers (assumed to be approximately 15 percent of the amount being transferred or up to 12,000 gallons) would result in substantial lethal and sub-lethal effects to intertidal organisms within contaminated beaches. Impacts would be localized.

Besides diesel fuel, spills of other hazardous substances being shipped to the site could occur as well. A variety of chemicals would need to be transported by barge to the site. These substances would include sodium cyanide, copper sulfate, xanthates, lead nitrate, and chlorine. These materials would be transported in conformance with U.S. Department of Transportation regulations (49 CFR Parts 100-199) that specify package construction, marking, proper transportation, and storage.

For example, approximately 320 tons of sodium cyanide, potentially the most toxic of these

materials, would be shipped to the site each year. The cyanide would be in solid form, packed in steel bins each containing 3,000 pounds. Other hazardous chemicals would be similarly packed in drums or bins. The drums or bins would be packed in International Standards Organization (ISO) containers for shipment by barge from Seattle. The two barge companies serving the inside waters of southeast Alaska from Seattle have never experienced a barge sinking or spilled container in those waters. The probability is low that the proposed project would experience a loss.

In the event of a container being lost from a barge, the individual bins or drums would need to rupture for a potentially toxic spill to occur. A reasonable worst case scenario involving sodium cyanide could consist of one bin being destroyed such that its entire contents are released into Lynn Canal. The chemical would readily dissolve in water and result in severely toxic concentrations in the immediate vicinity of the spill. Organisms encountering this solution would react immediately. Fish would become agitated, come to the surface, gulp for air, swim rapidly in circles at the surface, have convulsions, and then die (Leduc, 1984).

The mode of action of cyanide is fast but reversible. Fish encountering the solution that are able to escape to safe waters would recover with no ill effects (Leduc, 1984). Humans or other organisms that eat fish killed or injured by the spill would experience no adverse effects. Dangerous levels of cyanide from such a spill would be expected to dissipate rapidly with no lingering biological effects. Cyanide is purposely applied in large dosages to rehabilitate small lakes and to collect fish from rearing ponds (Leduc, 1984).

The severity of a fish kill resulting from a cyanide spill would vary depending on location, season, and species present. The extent of mixing by currents would determine the extent of losses. Schools of fish passing through the concentrated solution would suffer mortalities. Several thousands of fish could perish. Shellfish within the zone would also be impacted, as well as macrophytes (EPA, 1985b).

EFFECTS OF ALTERNATIVE B

The outfall location for this alternative is located north of Point Sherman. Diffuser depth and design have not been specified but would be within the ranges previously discussed with effects to aquatic organisms as previously discussed.

A fuel transfer and barge landing terminal would be constructed and operated under this alternative. Environmental impacts associated with constructing the facility would be slightly greater than those described above, assuming that the site currently being used would be enlarged to accommodate full project development needs.

All fuel needed for the project would be off-loaded from barges by pumping or piping at this site to the onshore storage facilities. The Applicant has committed to off-loading fuel only when waves are less than 3 feet. The potential impacts of fuel spills at this site were described previously.

A worst case scenario associated with a dam failure event would result in a deposition of material in Lynn Canal at the mouth of the project stream. (*See Geotechnical Considerations, Chapter 4*). Such an event, caused by an overtopping or piping type failure, would result in a very rapid discharge of approximately 630 acre-feet of water. This would occur within a period projected to be about 27 minutes, during which the peak flow would reach 17,000 cfs. About 215,000 tons of solids would be transported from the tailings and embankment, with up to an additional 600,000 tons that could be entrained by the flow downstream. Additional material could be entrained as a result of slides and hillside slumps triggered by the flow. Assuming a maximum load between 800,000 to 900,000 tons of solids transported by the flow, initial inundation of about 20 acres across the beach and into Lynn Canal could be expected. As this material was dispersed by wave action it would spread out. At a depth of 1 foot of material, approximately 560 acres could be inundated.

The effects of this scenario, which is not expected to occur under any of the alternatives, would be severe on all bottom associated

organisms. Attached animals would be destroyed. The substrate for animals living near the bottom would be made less suitable. Impacts associated with heavy metal depositions would be expected to occur in the immediate area, mainly due to bioaccumulation that occurs in sediment dwelling organisms.

EFFECTS OF ALTERNATIVE C

Considerations related to the outfall configuration and location are identical to those given for Alternative B.

This alternative would transfer impacts associated with constructing and operating a marine terminal to Slate Creek Cove within Berners Bay. All fuel supplies would be off-loaded at this site for transfer to the mill complex.

Impacts associated with the marine terminal would be significantly higher than for other action alternatives. Berners Bay is recognized as being a major estuarine habitat of Lynn Canal having a significant role in the reproductive and nursery phases of important species in the region (Myren, 1972; NMFS, 1974; Carlson, 1980; Bracken, 1990).

Construction activity within the marine environment would be increased significantly over that needed for other action alternatives. Impacts associated with site disturbance, placement of structures, and fuel spills would be substantially increased.

Operational accidents at this site would also significantly increase the potential for impacting the immediate area, though containment of spilled fuel would be easier. Risk of accident would likely be reduced at this site compared to Comet Beach due to the more protected nature of Slate Creek Cove. However, a major fuel spill at this site would likely result in a greater loss of aquatic life than should a spill occur within Lynn Canal proper.

EFFECTS OF ALTERNATIVE D

Comments related to the outfall configuration and location are identical to those given for Alternative B.

Potential impacts to the marine environment would be unchanged from Alternative B.

EFFECTS OF ALTERNATIVE E

Comments related to the outfall configuration and location are identical to those given for Alternative B.

Potential impacts to the marine environment would be nearly unchanged from Alternative B. Risk of metal-contaminated stream flows entering Lynn Canal would be slightly reduced, however, due to the method of tailings disposal.

EFFECTS OF ALTERNATIVE F

This alternative includes major differences in the outfall location and configuration than those described for the other alternatives. The outfall pipe would be routed to the south of Point Sherman. Diffuser design and depth have not been specified but would be within the ranges previously discussed. This alternative also includes three options for enhanced water treatment, in addition to the treatments associated with the other alternatives.

Differences in impacts to the aquatic biota associated with the options for water treatment, outfall depths and diffuser design are expected to be negligible. Marine discharge scenarios described earlier were found to pose little or no risks to aquatic populations. Scenarios that reduce concentrations or mixing zone size would therefore not reduce projected impacts, since these are expected to be minimal under any case.

Potential impacts to the marine biota are expected to be virtually identical to those described for a discharge north of Point Sherman. There would be less opportunity for possible fishing boat anchor fouling with the outfall pipe and diffuser south of Point Sherman, given the greater amount of fishing activity and anchorage that occurs north of Point Sherman. Also, concerns voiced by fishers about the perceived potential for greater retention of contaminants north of Point Sherman would be relieved through placement to the south.

Other impacts associated with this alternative would be identical to those described for Alternative B.

CUMULATIVE EFFECTS

Possible cumulative effects with other proposed mining projects in the region would be limited to potential impacts associated with Alternative C. Any adverse effects of operating the marine terminal at Slate Creek Cove on the biota of that area would potentially be exacerbated by development of the Jualin Project. Additional construction activities within Slate Creek Cove would likely occur as a result of development of the Jualin Project. The probability of events which could adversely affect Slate Creek Cove would also be increased.

The possibility of increasing metal bioaccumulation within species populations is unlikely given the inconsequential levels projected for the proposed project.

SUMMARY

Potential impacts associated with marine discharges from the project would be essentially the same under all action alternatives, provided that a suitable diffuser is designed to restrict the mixing zone to depths below the 20-meter photic layer. Bioaccumulation would not be expected to occur for any of the alternatives; biomagnification to higher trophic levels, therefore would not occur. No impacts would be expected to commercially important species due to the marine discharge.

No differences to the aquatic biota are projected for marine discharges located either north and south of Point Sherman.

Biological effects associated with construction and operation of a marine terminal at Comet Beach would be identical for Alternatives B, D, E and F. Impact potential would be greater for a terminal at Slate Creek Cove (Alternative C) because of ferry terminal construction in this alternative.

The risk of accident while off-loading supplies and fuel at Comet Beach (Alternatives B, D, E and F) would be greater than at Slate Creek Cove (Alternative C). To reduce the risk, the Kensington Venture has committed to only unloading barges at Comet Beach when waves are less than 3 feet. Impacts of a major fuel spill in Berners Bay, as could occur in Alternative C, could result in substantial loss of marine life within that estuarine habitat.

AQUATIC RESOURCES FRESHWATER

This section describes the potential impacts of the alternatives on the freshwater aquatic resources of the area.

EFFECTS OF THE NO ACTION ALTERNATIVE

No additional impacts on freshwater resources would occur over what would be associated with exploration activities.

EFFECTS COMMON TO ALL ACTION ALTERNATIVES

Some or all of the potential impacts common to the action alternatives would occur in Sherman Creek or its tributaries. These impacts would be associated with water withdrawal, runoff and sedimentation, and toxic spills.

Water Withdrawal

Each action alternative proposes a water withdrawal from upper Sherman Creek during periods of non-critical low flows. Water withdrawn would not be returned to the stream system.

Preliminary instream flow requirements for Sherman Creek have been provided by ADF&G (*See Table 4-10, Preliminary Instream Flow Requirements for Sherman Creek*). These levels would likely require that no withdrawal can be made, at least in some years, during December, January and February. Restrictions may also be required in some years during July. During these periods, alternative water sources may need to be utilized.

These water withdrawal restrictions would prevent any potential for adverse effects due to mining associated flow reductions. The mine operational plan will need to specify protocols

for regulating flow withdrawals to ensure compliance with flow requirements.

The potential impacts of withdrawals on the stream section within the area encompassed by the proposed Sherman Creek tailings impoundment and upstream to the diversion are covered under each of the separate alternatives.

Runoff and Sedimentation

Major construction activities would take place over 1 to 2 years in the affected drainages. Between approximately 229 to 392 acres of land would be disturbed, either entirely within the Sherman Creek drainage or split between Sherman and Sweeny creeks. Significant changes to topographic features would result in some areas. At least one water diversion facility and additional roads would be built. Four of the five action alternatives include major diversions of existing stream courses.

Control of storm runoff water quality during construction and mining operations would determine the extent of potential impacts to streams. Runoff and silt control systems would need to be well designed and in place early in the construction process. The facilities would require routine inspection, repairs, and modification throughout the life of the project as conditions and drainage areas change. All construction activities, such as grading and earthwork, would require implementations of BMPs to control soil erosion and sedimentation.

How well these systems are maintained and employed would largely determine the extent of impact to water quality, habitat, and stream biota from erosion and sedimentation. Proper implementation of Forest Service BMPs for erosion control would maintain water quality. Unseasonable rainfall patterns could overwhelm siltation control systems, however, and cause higher levels of impacts than expected. Adverse effects from such events can be minimized by defining in advance of initiating work the allowable conditions for construction, protocols for determining when to stop work due to weather events and a system of monitoring and maintaining all erosion control structures.

Regardless of measures taken, periods of above ambient levels of suspended sediment would result from construction activities within the drainages, especially during periods of rainfall and snowmelt. Clear definition of time windows for specific activities and criteria for modifying these would minimize the extent of above ambient turbidity.

Minimal levels of impact to the biota that could occur would likely be undetectable with any form of biological monitoring. Greater levels of impact, resulting from side slope failures and excessive siltation would be expected to reduce salmonid egg survival, juvenile salmonid overwintering survival, and benthic invertebrate abundance (Peterson et al., 1985). Incubating salmon eggs can be particularly sensitive to increases in fine sediments (Everest et al., 1987), especially from increased levels which occur late in the incubation phase, i.e., in later winter (Chapman, 1988). Impacts due to sedimentation occurring during the construction phase could be of relatively short duration (1 to 2 years).

Spills

Large quantities of fuel and chemicals stored and used at the project have the potential to cause major impacts to Sherman Creek and its biota in the event of an accidental spill. EPA regulations would require an SPCC Plan that meets specific criteria for responding to fuel spills.

Although spill containment equipment would be located at several sites and available for rapid deployment, fuel could enter Sherman Creek or a tributary very quickly in the event of a major spill. Such an event could result in significant mortalities to fish or embryos within the stream. Diesel fuel is particularly toxic to aquatic life compared to heavier grades of petroleum products (ADF&G, 1979), although its residence time within a stream environment like Sherman would be of short duration (inferred from Clark and Macleod, 1977). The extent of impact would be determined by the volume of material entering the stream, the presence of fish, and stream flow.

Chemicals, including sodium cyanide and chlorine, used in the milling process would be

delivered by barge, then trucked to the mill from the marine terminal. These materials would be packed in heavy steel shipping containers. Adequate safeguards against toxic spills would exist provided that transportation from the marine terminal, storage, and handling follow rigid protocols established in a hazardous substances management plan.

If these unprocessed materials should come into contact with Sherman Creek, significant loss of aquatic life would occur. The discharge of one bin of sodium cyanide into Sherman Creek would result in a major, if not total, loss of aquatic life throughout the entire reach of the stream below the spill site. The impact would occur as a single event with water quality quickly being restored to normal as the material, which is highly water soluble, was flushed from the stream (Leduc, 1984). Fish surviving the event would quickly recover (Leduc, 1984). Cyanide is not bioaccumulated (EPA, 1985b).

Another possible source of contamination to Sherman Creek would be from the pipeline carrying excess tailings water to Lynn Canal. Should the pipeline rupture or crack, effluent could quickly enter Sherman Creek, depending on the location of the occurrence and quantity released.

A worst case scenario would be a major break in the line with a large quantity of discharge entering Sherman Creek during winter low flow. Such a release lasting less than one day would likely result in mortalities to fish life within the stream, assuming low flow concentrations in *Table 4-11, Estimated Water Quality for the Mill and Tailings Impoundment Effluent - Alternatives B, C, D, and F*, and a dilution of 1:1 (impacts inferred from Lorz and McPherson, 1976; Davies, 1979; Leduc et al., 1982). Potentially lethal concentrations of cyanide, copper and ammonia could occur. Concentrations of other substrates, including various milling by products such as nitrates, nitrites, and sulfates, would pose no toxicity threat the extent of the impact would depend on the amount of effluent released into the stream.

EFFECTS OF ALTERNATIVE B

Impacts associated with this alternative would be confined to Sherman Creek drainage. These impacts would be due to stream diversions, a tailings impoundment, and project termination and reclamation

Stream Diversions

Three stream courses would be directly affected by this alternative: upper Sherman Creek above the confluence of Ophir Creek, Ophir Creek, and an unnamed tributary of upper Sherman Creek.

Upper Sherman Creek, beginning at the domestic water diversion intake, would be routed through a buried pipeline around the mill complex and tailings pond and then discharged back to the natural stream channel below the tailings dam. A tributary to upper Sherman Creek would be routed through the same pipeline. Total length of the pipeline would be approximately 5,280 feet.

The pipeline would be capable of containing the peak 25-year, 24-hour flood event from these two drainages. Flows in excess of the 25-year flood event would be shunted off at the diversion site and discharged to the tailings pond.

The entire Ophir Creek drainage, upstream of the area encompassed by the proposed tailings impoundment, would be diverted through a constructed channel around the impoundment and discharged down a concrete spillway to lower Sherman Creek. Energy dissipation would be required in the spillway and where the flow enters Sherman Creek. The Ophir Creek diversion channel (about 2,950 feet long) and the return spillway (about 1,050 feet long) would be built to safely pass the estimated PMF.

These diversions would be fatal to fish residing within the natural stream channels. The diversions would eliminate approximately 6,000 feet of stream. The habitat in this area is characteristic of steep headwater streams that support resident salmonids. All fish in this section would be lost as a result of this action with the exception of a few near the lower end that could escape when flows are cutoff. The density of Dolly Varden in this reach was assessed to be approximately one fish per 500 square feet of water surface area in July, 1991 (Konopacky Environmental, 1991), a low density

typical of steep streams containing resident salmonids.

The Ophir Creek diversion would consist of rechanneling approximately 2,000 feet of existing stream course. The lower reaches of this stream support small numbers of resident Dolly Varden with densities comparable to those in the upper reaches of the mainstem Sherman Creek (Konopacky Environmental, 1991). The upper reaches of the stream are nearly vertical and apparently freeze during winter.

Diversion of the reaches of the Sherman Creek system would destroy between approximately 400 to 500 resident Dolly Varden.

Stream temperatures in lower Sherman Creek during summer would not be expected to be detrimentally altered by the diversions in upper Sherman Creek and Ophir Creek. The only reaches that would be potentially more exposed to sunlight following land development than before would be those in Ophir Creek. Ophir Creek is particularly cold compared to Sherman Creek, as well as the adjacent Sweeny Creek, probably due to its steepness and origin in nearby snowfields (Konopacky, 1991).

In 1991 temperatures in lower Sherman Creek were found to be significantly colder than at least some other streams in the area, e.g. Sweeny Creek (*See Chapter 3 Aquatic Resources - Freshwater*). An increase in stream temperature in lower Sherman Creek as a result of the proposed project, though not predicted, would be expected to enhance fish production in those reaches (*See Chapter 4, Surface Water Hydrology*).

Tailings Impoundment

This alternative includes a tailings dam built across a constricted section of Sherman Creek upstream of the existing anadromous barrier. A seepage collection facility would be located immediately downstream of the dam to collect all seepage through and under the dam. Water collected at this site would be pumped back to the mill process water system. The purpose of this collection facility is to protect lower Sherman Creek from contamination by tailings seepage.

Fish habitat inundated by the dam and associated pond was previously described.

Stream flow downstream of the dam would be reduced during project life since the size of the drainage area would be effectively reduced by about 10 percent (i.e., the area contained by the tailings pond and associated facilities). This could serve to partly temper high flow events in the lower stream, particularly those events greater than the 25-year event, thereby providing a measure of protection to incubating embryos from scour during floods.

All seepage from the impoundment would be pumped back as recycle water under the proposed plan. If this system fails, some water could pass downstream. Although such material would be expected to be relatively low in metal concentrations (*See Chapter 4, Ground Water*), downstream monitoring would be needed to ensure that background metal levels are not exceeded. Should levels be found to be increasing over time, additional measures would be required to prevent further contamination. No impacts to the biota would be expected if such measures would be taken.

A worst case scenario would be a dam failure resulting from an over-topping or piping type failure. Such a failure is projected to result in a peak flow release into Sherman Creek of approximately 17,000 cfs and about 215,000 tons of solids transported from the tailings and the embankment. Peak discharge would be approximately 17 times the instantaneous peak discharge associated with a 25-year flood event (Kensington Venture, 1989). About 215,000 tons of solids would be transported from the tailings and embankment, together with additional material entrained by the flood downstream. Such a flow would result in very severe disruption to the lower Sherman Creek environment.

The streambed would be destabilized and the gravel substrate scoured. Existing habitat structure associated with large woody debris would be destroyed. Slides or slumps along some areas of the stream could be triggered, bringing in new material, including both sediment and trees. As stream flow rapidly declines sediment would be deposited in some areas of the stream. Fish and aquatic

vertebrates would be reduced to very low levels as a result of these events though likely not eliminated. Subsequently, the stream could be expected to recover over a period of several years. Extensive recolonization of streams devastated by Mt. Saint Helens in Washington has occurred within a period of 10 years demonstrating the resiliency of natural populations to recover following a destructive environmental event.

Project Termination and Site Reclamation

Following project termination, the applicant proposes and would be required by the Forest Service to reclaim the site. The Sherman Creek channel would be reconstructed through the upper portion of the tailings impoundment area to the Ophir Creek diversion near the dam. The Sherman Creek diversion would then be closed off. Both Ophir and Sherman creeks would be routed through the tailings structure. All flows would be routed into lower Sherman Creek downstream of the dam. Permanent erosion control measures would be taken to protect surface waters from siltation originating on disturbed areas or the roads.

Reclamation of tailings areas frequently has not occurred in the past (e.g., Sutherland and Thompson, 1986). The effectiveness of the proposed plan for making the site suitable for fish production would depend on site stability and water quality. Highest priority in reclamation efforts would be given to ensuring channel stability, followed closely by the desire to re-create viable populations of resident fishes. The Applicant's conceptual reclamation plan for the tailings impoundment would provide an opportunity to evaluate the design and reclamation methods for these types of projects. Given naturally low densities of resident Dolly Varden in Sherman Creek, the potential exists to create habitat capable of producing more fish than currently occurs. Stock from the upper reaches of Sherman Creek upstream of the proposed diversion would be used to rebuild the population in the area to be reclaimed. Utilizing stock from the same stream would insure that the genetic integrity of the population would be maintained.

Few studies have been conducted to evaluate cyanide residues in tailings solids following termination of operations, though available information suggests that iron cyanides would be the predominant form at Kensington based on a report by Mehling and Broughton (1989). Under non-acidic conditions, as would occur for the proposed project, ferro- and ferri-cyanide would likely be the predominant forms (Chatwin, 1989). These forms are relatively stable and benign.

EFFECTS OF ALTERNATIVE C

This alternative would result in impacts to two fish-producing streams. The effects on the biota of Sherman Creek would remain unchanged from Alternative B. Additional impacts could occur to Sweeny Creek due to construction and operation of an access road, pipeline, and transmission line between Berners Bay and Sherman Creek. The road would cross Sweeny Creek in the lower reaches of the stream. A bridge would need to be constructed at that site.

Impacts to the aquatic species in Sweeny Creek could occur due to construction-related siltation, sedimentation from road runoff, and accidental spills of toxic materials being trucked or piped across the drainage. Fuel and chemical supplies would not be delivered to Comet Beach under this alternative, but instead would be delivered to Slate Creek Cove and trucked or carried by pipeline to the project site. All potential impacts to Sweeny Creek would occur within the lower 1,000 feet. Extent of impacts would be as described previously for these types of activities.

EFFECTS OF ALTERNATIVE D

Impacts to Sherman Creek would be reduced significantly with this alternative compared to Alternatives B and C. Upper Sherman Creek and Ophir Creek would not be diverted (water diversion in Sherman Creek for domestic purposes would still occur), nor would the tailings impoundment be located in the drainage. All other potential impacts described for Alternative B would remain.

Alternative D would transfer impacts associated with stream diversion and construction of a tailings impoundment to Sweeny Creek.

Stream Diversion

In order to construct and operate the tailings impoundment, over 6,000 feet of Sweeny Creek would be diverted. Streamflow would be shunted Into a new channel or ditch at the upstream edge of the tailings impoundment and directed around the north side of the structure. Drainage from the opposite valley wall would be diverted through another channel along the south bank of the impoundment. In total, over 15,000 feet of diversion channels or ditches around the impoundment would be created by the end of the project.

Sweeny Creek in the impoundment area contains populations of Dolly Varden and cutthroat/rainbow trout (Konopacky, Environmental, 1991). These populations appear to consist at least partially of anadromous fish, in addition to resident forms. Any upstream access that may now exist would be blocked by construction of the tailings dam.

The extent of impact to these fish populations would depend on how rechannelization is accomplished. If the principal diversion is designed simply to transport water and is progressively built as the impoundment grows, then the populations would likely be effectively destroyed. Some fish would continue to recolonize from areas upstream but survival would be low.

The expected result of these diversions, at least in the short-term, would be a significant depletion in char and trout production in Sweeny Creek. This stream supports a higher abundance of fish than upper Sherman Creek. Accordingly losses would be greater than those that would occur due to an impoundment in Sherman Creek.

Following closure, rehabilitation of aquatic habitat in the diversion channel would be necessary so that this section of the stream could maintain healthy, viable fish populations.

Construction of diversion channels would also result in siltation to downstream areas and additional impacts to salmonids in the lower portions of the stream. In 1990, an estimated 2,000 pink salmon spawned in lower Sweeny Creek.

Tailings Impoundment

A tailings impoundment dam would be built across Sweeny Creek. The potential impacts to this stream would be essentially identical to those described for Sherman Creek (Alternative B). The drainage area producing flow to the lower stream would be eventually reduced by a maximum of 8 percent.

EFFECTS OF ALTERNATIVE E

This alternative would require the least amount of disruption to stream habitat. A tailings dam would not be built across an active stream channel and no streamways would be relocated for either dry disposal site option (*See Chapter* 2). All habitat used by resident char and cutthroat would remain essentially intact.

Because of disposal structure size, shape, and location near Ophir and Sherman creeks, dewatered tailings disposal Site A has the greatest potential to impact stream habitat should a structure failure occur at this site. Distances from Sweeny and Sherman Creeks to dry disposal Site B are greater and slopes between Site B and the creeks are less steep than those between Site A and Sherman and Ophir creeks. Therefore, a structure failure at disposal Site B would be less likely to impact stream habitat.

Potential water quality problems associated with tailings seepage would likely be less with this alternative compared to wet tailings disposal, but surface erosion and possible sedimentation impacts would be greater with dewatered tailings disposal.

EFFECTS OF ALTERNATIVE F

Effects of Alternative F would be the same as described under Alternative B.

CUMULATIVE EFFECTS

Each of the action alternatives would have potential cumulative effects on Dolly Varden in the region due to the habitat destruction. The A-J Mine, for example, would result in more substantial destruction of resident Dolly Varden and their habitat than would occur as a result of a Kensington Project. Losses could also occur

if the Jualin Project is developed. While each of these losses would be significant for a period of time to the population located within the altered stream, the combined loss would likely be negligible in terms of the total population of resident Dolly Varden in southeast Alaska.

This loss of fish in Sherman Creek or Sweeny Creek would be temporary, as the potential to rebuild the run exists. Furthermore, the loss would not be to genetic material because both streams are inhabited by resident fish upstream of the proposed diversion points.

No other cumulative effects would be expected to freshwater resources.

SUMMARY

Potential impacts of the proposed project would be concentrated in a single drainage in three of the action alternatives (B, E and F). With the other two alternatives (C and D), impacts would occur in two drainages, though relatively minor impacts would only occur in the second drainage with Alternative C.

The potential impacts of flow reductions on the lower reaches of affected streams would be negligible for each alternative. No water withdrawals would occur when stream flows reach a minimum acceptable level, which would be set by permit.

Impacts by siltation should be significantly less in Alternative E, compared to the others. Effects of siltation would likely be most severe in Alternative D, where impacts would include two drainages. Potential impacts associated with possible contamination by heavy metals would follow the same pattern between alternatives.

The potential for spills is considered highest for Alternative C because of the additional distance involved in transportation of toxic products.

Major stream diversions would occur for four alternatives (B, C, D, and F) and would result in impacts to resident salmonid populations. Losses for Alternative D would involve two species, cutthroat and Dolly Varden, while only Dolly Varden is expected to be affected by Alternatives B, C and F. Habitat eliminated by Alternative D could possibly be used by anadromous forms of the affected species.

SOILS/VEGETATION/ WETLANDS

This section discusses the expected impacts of the five alternatives on soils, vegetation, and wetland resources. Native vegetation on the Kensington Project area plays an important role in controlling erosion, providing wildlife habitat, and maintaining biological stability. Disturbance to the vegetation resources could result in impacts to these ecosystem functions. While impacts related to soils and vegetation removal or disturbance are usually considered negative, long-term positive benefits (in terms of wildlife habitat diversity) can sometimes be derived from the application of appropriate reclamation measures.

EFFECTS OF THE NO ACTION ALTERNATIVE

Under this alternative no further impacts, other than those existing from on-going exploration, would occur to soils, vegetation, and wetland resources. Reclamation of the existing disturbances would mitigate these impacts.

EFFECTS COMMON TO ALL ACTION ALTERNATIVES

Soils

Adverse impacts to soil resources would result from increases in erosion and loss of soil productivity. The level of potential erosion is a direct result of the amount of disturbance and the sedimentation controls implemented and maintained. The potential of significant erosional impacts would be highest during initial construction periods. As construction activities proceed, disturbed areas would be stabilized as soon as practicable to reduce the impacts of erosion. Once disturbed areas are stabilized and sediment control measures implemented, erosional impacts should be minimized.

Disturbed soils typically experience a loss of nutritional and physical structure which can retard the successional development of vegetation. USDA-Soil Conservation Service (1983) and Williams and Schuman (1987) were

reviewed and onsite soils data were interpreted to evaluate the reclamation potential of project area soils. Interpretation of this information reveals that several potential limitations exist with respect to the reclamation suitability of existing soil materials. These limitations are related primarily to shallow soils, poor texture of organic soils, wetness, low pH (less than 4.5), and nutrient deficiencies (*See DEIS Appendix Table D4-5, Kensington Soil Materials Chemical and Physical Properties*).

Textures of the existing Kensington waste rock and mill ores are sandy, which reduces their potential as a reclamation plant growth medium. Nutrient deficiencies appear likely with respect to nitrate, nitrogen, phosphorus, and potassium for nearly all of the mine soil materials tested. However, deficiencies in these essential plant nutrients can easily be corrected with supplemental fertilizers.

Potential for acid formation from exposed fresh ore was considered. Since the ore body exposed at the surface above the old Kensington Mine has not turned acidic over geologic time, the potential of the ore materials becoming acidic is very remote. The pyritic sulfur contents in both the surface exposed ore and waste rock materials have not oxidized, and thus, there is no evidence to suggest that the mine ore or waste rock materials would do so. (*See DEIS Appendix D, Table D4-5, Kensington Soil Materials Chemical and Physical Properties*). As long as the pyritic portion (4 to 7 percent) of the ore is recombined with the remaining tails (93 to 96 percent) after gold extraction, acid formation would not be expected to occur. The calcium carbonate content of the non-pyritic tails is more than sufficient to neutralize any acid formation as evidenced by the data presented in *DEIS Appendix Table D4-5, Kensington Soil Materials Chemical and Physical Properties*.

Specific studies regarding the reclamation potential of disturbed sites have not been conducted for the project area. However, certain inferences can be made from other evaluations in the region. Intensive ecological and soils characterization efforts have been made on the processes of plant and soil development on receding glaciers in southeastern Alaska for nearly 100 years (Alaback, 1982). Although, corresponding patterns of soil development on the many disturbances associated with the numerous landslides in the region have received less study (Gregory, 1960).

More recently, mining related and various other types of surface disturbances have been evaluated (Alaback, 1982). In this work, old tailings on Douglas Island were studied. It was found that soil depth, texture, color, and structure could not be correlated with the understory growth that had developed on disturbed sites. The study also determined that disturbed slopes ranging from 20 to 47 percent did not have understory production significantly different from undisturbed sites where thin rocky soils or anomalous soil materials were present. Also, areas of old mine tailings from the Treadwell Mine had plant understory production nearly four times that measured on other sites having less disturbed soils.

These findings suggest that, although many of the region's soils have inherent limitations with respect to reclamation potential, many disturbed areas can be stabilized and successfully revegetated. Revegetation observed on many of the previously disturbed areas associated with the old Kensington Mine and current exploration disturbances confirms this expectation (IME, 1991c).

Vegetation

Project development would result in the clearing of vegetation from all project facility areas. These areas would be devoid of vegetation and wildlife habitat for the life of the mine. At mine closure disturbed areas would be stabilized and reclaimed according to a Forest Service approved reclamation plan. Due to the abundance of rainfall, vegetation is expected to rapidly reestablish on stabilized reclaimed areas. The development of vegetation communities should occur in a manner similar to that found on areas clear cut for timber in this region.

Vegetation in the project area would be directly affected by clearing, excavation, and placement of fill for facilities construction. The total amount of surface disturbance varies for each action alternative (*See Table 4-18, Vegetation Disturbance by Action Alternative*). Specific

vegetation resources which would be affected by the action alternatives include timber and old-growth forest.

Table 4-18, Vegetation Disturbance by Action Alternative (Acres)

General Vegetation Type	Alternative B	Alternative C	Alternative D	Alternative E		Alternative F
				Site A	Site B	
Hemlock/Spruce Forest	44.1	57.4	65.0	18.2	31.2	44.1
Hemlock Forest	122.8	130.5	117.4	143.9	78.1	122.8
Low Sites (mixed conifer, muskeg & forb/grass/sedge)	100.9	194.9	39.8	77.1	124.9	102.9
Muskeg Forest	0.8	2.8	1.1	0.8	0.8	0.8
Recurrent Slide Zones (Alder)	5.3	5.3	4.6	0.9	0.9	5.3
Alpine	1.1	1.1	1.1	1.1	1.1	1.1
Total	275.0	392.0	229.0	242.0	237.0	277.0

Timber Resources. Estimates on the amount of potentially marketable timber to be removed by each of the action alternatives are presented on *Table 4-19, Timber Removed by Action Alternative*. Timber supply estimates for the Tongass National Forest (USDA Forest Service, 1989) indicate that annual timber harvests average 3,333.7 million-board-feet. The timber harvested as a result of an action alternative would not cause any change in the amount of marketable timber in the region since the proposed project area occurs within an LUD II management area.

Table 4-19, Timber Removed by Action Alternative (Timber Loss in Thousand-Board-Feet)

Project Alternative	Acres Loss	Timber
Alternative B	198.9	5,431
Alternative C	280.4	6,066
Alternative D	153.6	3,935
Alternative E - Site A	204.3	8,969
Alternative E - Site B	145.4	4,090
Alternative F	198.9	5,431

Old-Growth Forest. Recently implemented federal provisions provide that all timber harvest activities on federal forest lands must address the presence of old-growth forest. While no formal evaluation procedures have been developed for the Tongass National Forest, timber inventories have been used to delineate potential old-growth areas. Comparison of the layouts of each action alternative with Tongass GIS mapping of old-growth areas provides estimates of potential disturbance to old-growth timber. (*See Table 4-20, Old-Growth Forest Removed by Action Alternative*).

Table 4-20, Old-Growth Forest Removed by Action Alternative

Project Alternative	Disturbance (acres)
Alternative B	86.5
Alternative C	121.4
Alternative D	152.0
Alternative E - Site A	104.9
Alternative E - Site B	76.9
Alternative F	86.5

Threatened and Endangered Species. No federal or State listed threatened or endangered plant species are known to occur in the project

area. Field surveys verified the existence of western paper birch (*Betula papyrifera* var. *commutata*) (IME, 1991c). Western paper birch is proposed for consideration for listing as sensitive under the State program. This species was determined to be relatively common in the study area. Based on population estimates made during the field surveys, approximately six populations of this plant would be destroyed by development of the Sherman Creek tailings impoundment. A small number of this species could also be lost through construction of the Berners Bay access road (Alternative C). As indicated in Chapter 3, it is not expected that this species will be included on the State sensitive list when it is finalized.

Wetlands

Wetlands have significant ecosystem values in terms of biological diversity, productivity, and sedimentation control. The federal Government, through Executive Orders 11988 and 11990, has mandated that federal agencies provide leadership for preserving floodplains and minimizing losses to wetlands. Most impacts to wetlands are governed by the provisions of Section 404 of the Clean Water Act, which requires permit approval for any dredge or fill alterations to wetland environments.

Losses of wetlands would result from all action alternatives. (*See Table 4-21, Direct Wetland Loss by Action Alternative*). In order to relate these losses to wetland functions and values, a "wetland importance value" was determined for the total extent of wetlands lost with each action alternative. The wetland importance value was obtained by assigning a ranking of 1, 2, or 3 to each wetland functional ranking of low, moderate, and high, respectively (*See DEIS Appendix Table D4-11, Kensington Wetlands Functions and Values*). These rankings were totaled for each wetland plant association and then multiplied by the total acres lost with each action alternative. The results of this evaluation are summarized in *Table 4-22, Relative Importance of Wetlands Lost*. The rankings presented in this table indicate that Alternative D would have the least impact on wetland functions and values, while Alternative C would have the greatest impact. Alternative E would be the only action alternative which would not directly affect stream wetland habitats through tailings disposal.

Table 4-21, Direct Wetland Loss by Action Alternative

Project Alternative	Wetland Disturbance (acres)
Alternative B	232.8
Alternative C	335.9
Alternative D	123.5
Alternative E - Site A	181.7
Alternative E - Site B	228.6
Alternative F	234.8

Table 4-22, Relative Importance of Wetlands Lost

Project Alternative	Wetland Importance Value
Alternative B	4,759
Alternative C	6,387
Alternative D	2,735
Alternative E - Site A	3,549
Alternative E - Site B	4,568
Alternative F	4,811

Indirect effects on wetland resources could potentially occur as a result of proposed stream diversions, dewatering, and construction. Possible reduction of ground water levels during these activities could result in the reduction of the extent and vigor of wetland vegetation located in areas adjacent to areas of disturbance. The total extent of these impacts are difficult to determine, however, since sediment control facilities and increased runoff from disturbed areas could result in locally significant increases in surface moisture. Proposed and required sediment control measures would minimize any effects of sedimentation on adjacent undisturbed wetland areas.

federal policy for determining the mitigation necessary to demonstrate compliance with the Clean Water Act, Section 404(b)(1) Guidelines is specified in the Memorandum of Agreement (MOA) between the Corps of Engineers and the EPA. This MOA applies to discharges of dredged or fill material to waters of the United States, including wetlands. The MOA expresses

the goal of no overall net loss of wetland functions and values and defines the sequence of mitigation applicable to activities permitted under Section 404. The sequence for mitigation is predicated on the Council on Environmental Quality (CEQ) regulations at 40 CFR 1508.20 and includes three general types: 1) avoidance of impacts, 2) minimizing impacts, and (3) compensation for impacts.

Avoidance of impacts requires that no discharge (i.e. filling of wetlands) shall be permitted if there exists a practicable alternative to the proposed discharge which would have less adverse impact, provided the alternative does not have other significant adverse environmental consequences. Avoidance is also based on the initial presumption that, for non-water dependent activities, a practicable alternative to discharges into wetlands exists. Minimization of impacts must also be considered to assure that all possible modifications to the project have been incorporated to minimize the extent of wetland impacts. Compensation for unavoidable impacts (e.g., restoration of existing degraded wetlands or creation of man-made wetlands) is considered only when all appropriate and practicable measures to avoid and minimize impacts have been taken.

The MOA includes guidelines for determining appropriate and practicable compensatory mitigation. The sequencing of mitigation is intended to correspond with the NEPA review process. Compensation for wetland loss should, whenever possible, be undertaken in areas adjacent or contiguous to the impacted area. If onsite mitigation is not practicable, compensation should be undertaken in the same geographic area (i.e. watershed). Compensatory mitigation must take into consideration the lost functional values of the wetland resources impacted, and in-kind replacement is preferable to out-of-kind. Due to uncertainties regarding the success of wetlands creation, wetlands restoration would be the first option considered.

Because of the predominance of wetlands in the project area, except on the steeper slopes where facility development would be infeasible, avoidance of all impacts to wetlands would be impossible with any of the action alternatives. If project development occurs, then compensatory mitigation in the form of restoration or replacement would be required as part of the final reclamation plan. The Corps of Engineers has indicated that if compensatory mitigation is required, the opportunity for that mitigation on site or in the near vicinity is limited. However, it does appear that upon closure, if restoration is required, it is likely to succeed. Therefore, much of the mitigation which might be required is expected to be directed towards restoration of the site (Justis, 1991; 1992). The Corps of Engineers will need to complete the public interest review process and give full consideration to all comments received before reaching its final conclusion on 404 compensatory mitigation.

Field evaluation of several previously disturbed wetland areas within the Sherman Creek basin at the old Kensington Mill site, as well as along the old roads, railroad and tramways suggest that the potential for wetlands reestablishment on disturbed areas is high (IME, 1991b). On all of these areas (except those on the very steepest slopes), soils, vegetation, and hydrological conditions had been reestablished to a sufficient degree that these previously disturbed areas met the criteria for jurisdictional wetlands. These findings are encouraging regarding the potential for mitigation and reestablishment of wetlands in most areas lost as a result of implementation of an action alternative.

EFFECTS OF ALTERNATIVE B

This alternative would disturb 275 acres of soils and vegetation. Approximately 5,431 thousand-board-feet (MBF) (198.9 acres) of timber and 86.5 acres of old-growth forest would be removed. Of the total 275 acres of possible disturbance, 232.8 acres are classified as wetlands. Six small populations of western paper birch (approximately 0.1 acre) would be removed by this alternative.

EFFECTS OF ALTERNATIVE C

This alternative would disturb 392 acres of soils and vegetation. Approximately 6,066 MBF (280.4 acres) of timber and 121.4 acres of old-growth forest would be removed.

Of the total 392 acres of possible disturbance, 335.9 acres are classified as wetlands. Because of the Berners Bay access road, this alternative would disturb the greatest extent of wetlands and has a greater potential for indirect impacts to wetlands as a result of sedimentation and spill potential. The same six small populations of western paper birch (approximately 0.1 acre) affected by Alternative B also would be removed by this alternative. A few small populations of this species may also be impacted by the access road from Slate Creek Cove.

EFFECTS OF ALTERNATIVE D

This alternative would disturb 229 acres of soils and vegetation. Approximately 3,935 MBF (153.6 acres) of timber and 152.0 acres of old-growth forest would be removed. Of the total 229 acres of possible disturbance, 123.5 acres are classified as wetlands.

EFFECTS OF ALTERNATIVE E

This alternative would disturb 242 acres of soils and vegetation with the Site A option and 237 acres of soils and vegetation with the Site B option. Approximately 8,969 MBF (204.3 acres) of timber, of which 104.9 acres are old-growth forest, would be removed with the Site A option. About 4,090 (145.4 acres) of timber, of which 76.9 acres are old-growth forest, would be removed with the Site B option. Total possible wetland loss with this alternative would be 181.7 acres with Site A and 228.6 acres with Site B. Because of the configuration and placement of the two dewatered tailings structure options, it is expected that it would not be possible to reestablish wetland habitats on the dewatered tailings piles.

EFFECTS OF ALTERNATIVE F

Impacts associated with this alternative would be the same as Alternative B except an additional 2 acres of wetlands would be disturbed.

CUMULATIVE EFFECTS

Cumulative effects to vegetation resources resulting from the proposed Kensington Project are difficult to determine. Potential cumulative effects to old-growth forest and wetland resources in the Tongass National Forest could result if additional projects (e.g., Jualin Project) were to become operational. Additional disturbances to the soils resource would also occur if the Jualin Project were developed.

SUMMARY

Anticipated impacts to soils, vegetation, and wetlands resulting from the four action alternatives are directly related to the area of estimated disturbance. Alternative C would disturb the greatest extent of total acreage and wetlands. Alternative E would disturb the least amount of old-growth forest (Site B). Alternative B and F would remove the least amount of old-growth forest after Alternative E - Site B. Alternative D would disturb the least amount of total acreage and wetlands.

Reclamation would eventually mitigate most impacts to soils, vegetation, and wetland resources. However, there would be a long-term loss of old-growth forest habitats and, possibly, some wetland habitats, especially with Alternative E. It is anticipated that reestablishment of wetland habitats would be impossible on either of the reclaimed dewatered tailings structure options. The potential for wetland reestablishment would be much higher with the conventional tailings structures in Alternatives B, C, D, and F.

WILDLIFE

This section describes the expected impacts of the project alternatives on wildlife species and habitats.

EFFECTS OF THE NO ACTION ALTERNATIVE

Existing habitat disturbance and human presence disturbances associated with exploration could continue to occur under current permits issued by the Forest Service. No additional disturbances to wildlife would be expected. Reclamation would eventually mitigate existing habitat loss.

EFFECTS COMMON TO ALL ACTION ALTERNATIVES

The principal categories which would potentially impact wildlife populations under all action alternatives are direct habitat removal or alteration, increased human presence and activities, and degradation of surface water quality. Since many of the potential effects associated with these impact categories are expected to be the same for each action alternative, these effects are discussed in general terms in this section. Impact considerations specific to each action alternative are discussed in subsequent sections. For all impact discussions, particular emphasis is placed on species of special concern for the Kensington Project (determined through public and agency scoping meetings), game species, and other potentially sensitive species.

Habitat Loss and Human Presence

Habitat losses are associated with development sites that would not be reclaimed for the duration of project operations (approximately 12 years). Although final reclamation would be initiated during mine closure phases, revegetation efforts would not be able to replace old-growth forest habitats that were lost during development. Because it takes centuries for old-growth forest characteristics to develop, clearing of forested areas within the project area would result in long-term alteration of existing habitats.

Reclamation would focus primarily on replacement of cleared forested habitats with native grass-shrub communities. Reestablishment of trees would occur primarily by natural succession, and could take 25 years or more. Establishment of grass-shrub communities within existing areas of forested habitats would initially increase habitat diversity and possibly, vegetation productivity at reclaimed sites. (*See Soils/Vegetation/ Wetlands, Chapter 4*). However, habitat diversity and vegetation productivity would decrease once reclaimed areas are invaded by second-growth trees.

In southeast Alaska, second-growth forests, ranging in age from approximately 25 to 100 years, typically develop a dense overstory of relatively even-aged trees. This dense overstory decreases the amount of light reaching the forest floor and results in a rapid depletion of understory vegetation. The reduction in habitat diversity created by second-growth forests can be mitigated, to some extent, through management practices incorporated into the reclamation plan. Techniques such as selective thinning and corridor development would increase habitat diversity and productivity. Specific techniques to improve habitat diversity within reclaimed areas would be developed as part of the final reclamation plan. Monitoring of revegetation efforts would determine if additional management practices would be necessary to create productive habitats and achieve revegetation success.

Replacement of wetland habitats would depend on the success of reclamation efforts to create surface and subsurface hydrologic conditions favorable to wetland establishment. Evaluations of project area sites previously disturbed by historic mining activities indicate that the potential for wetland reestablishment is high (*See Soils/Vegetation/Wetlands, Chapter 4*).

Habitat disturbance would result in some direct losses of smaller, less mobile species of wildlife, such as small mammals and amphibians, and displacement of more mobile species to adjacent undisturbed habitats until operations cease and reclamation has been completed. If it is assumed that existing adjacent habitats are at carrying capacity for most species, locally displaced populations may be eliminated for the life of the mine and until reclamation is successful.

Predictions of wildlife population losses based on habitat disturbance and displacement are difficult to make since accurate information on wildlife population numbers is not available and is often impossible to obtain for many species. Even if accurate population numbers were available, projections of losses may not be accurate since it is impossible to take into account the effects of other factors such as weather and natural cyclical population changes.

Because of the difficulties related to wildlife impact projections, models developed for

Tongass National Forest Management Indicator Species were used to assess impacts to some of the species of concern identified for the Kensington Project. Forest Service projections or changes to identified habitats of Management Indicator Species are used to assess the results of decisions relating to the management of Tongass National Forest lands. Habitats of these Management Indicator Species have been mapped based on habitat capability models jointly developed by the Forest Service and ADF&G biologists. These models represent the current "state-of-the-art" in our predictive modeling capabilities.

Through the use of these models, loss of Management Indicator Species habitat can be evaluated for disturbances such as timber removal or mining. These models also predict the number of animals potentially supported in an area based on habitat capability values computed for existing habitats. Population estimates derived from the models should not be construed as actual estimates of existing populations, but can be used to compare the relative magnitude of impacts among development alternatives. It is Interesting to note, however, that population projections for mountain goat are in close agreement with population estimates the ADF&G has projected from recent aerial surveys (*See Wildlife, Chapter 3*).

The area between the Berners River and Lynn Canal from Point St. Mary north to approximately the boundary between the Haines Borough and the City and Borough of Juneau (78,650 acres) was selected as the initial area of focus for the model impact projections for the Kensington Project. Acres of habitat and habitat capability population numbers were projected using the models for a selected group of species. (*See Table 4-23, Model Projected Impacts for Management Indicator Species*). Four of the species (bald eagle, brown bear, black bear, and mountain goat), for which modeled impact projections were developed, were also designated as species of special concern for the Kensington Project.

Table 4-23, Model Projected Impacts for Management Indicator Species

Species	No Action		Alt B and F		Alt C		Alt D		Alt E	
	Area[1]	Pop[2]	Area[1]	Pop[2]	Area[1]	Pop[2]	Area[1]	Pop[2]	Area[1]	Pop[2]
Bald Eagle	2,786	68	2,776	68	2,746	68	2,746	68	2,746	68
Blue Grouse	34,800	2,230	34,618	2,220	34,283	2,209	34,121	2,193	34,172	2,198
Hairy Woodpecker	15,941	249	15,870	248	15,819	247	15,687	246	15,728	246
Red-breasted Sapsucker	34,800	3,570	34,618	3,553	34,283	3,537	34,121	3,509	34,172	3,517
Brown Creeper	4,337	102	4,337	102	4,337	102	4,337	102	4,337	102
Red Squirrel	36,361	27,615	36,128	27,398	35,793	27,179	35,621	27,015	35,692	27,098
Marten	28,932	79	28,699	79	28,365	79	28,193	78	28,264	78
River Otter	5,391	29	5,330	29	5,158	28	5,158	28	5,158	28
Brown Bear	64,078	85	63,885	85	63,551	84	63,388	84	63,439	84
Black Bear	63,429	92	63,226	92	62,892	91	62,730	91	62,780	91
Mountain Goat	20,339	71	20,339	71	20,339	71	20,339	71	20,339	71

[1]Habitat in acres.
[2]Habitat capability in no. of animals.

Acres of habitat and population estimates for the No Action Alternative are provided to represent existing conditions. Acres of habitat provided for each action alternative represent the total amount of remaining habitat not directly disturbed by project components (*See Table 4-23, Model Projected Impacts for Management Indicator Species*).

These modeled impact projections indicate only minor reductions in habitat capability for each action alternative. In addition, differences among the action alternatives are small. However, reductions in habitat capability are based solely on direct loss of habitat and may not provide an accurate assessment of impacts for species that are expected to be more sensitive to human presence.

Model estimates for loss of habitat and corresponding losses in habitat capability may provide reasonable predictions for species such as red squirrel, hairy woodpecker, and brown creeper. These species would not be expected to be Impacted to any great extent beyond the actual disturbance areas. However, modeled estimates for potentially more sensitive species (e.g. mountain goat) do not reflect the extent of habitat potentially lost due to animal avoidance.

For species such as mountain goat and black bear, displacement caused by increased levels of human presence and noise would be expected to result in a greater loss of habitat and habitat capability than that indicated by direct habitat disturbance. For example, none of the action alternatives would create additional disturbance in mapped mountain goat habitat (*See Table 4-23, Model Projected Impacts for Management Indicator Species*). Noise associated with construction and helicopter use would extend, however, beyond the areas of actual disturbance and may result in losses of mountain goat habitat due to mountain goat avoidance of suitable habitats affected by noise. Details on noise levels and the timing of construction and operational activities are provided under *Noise, Chapter 4*.
Noise modeling for tailings facility construction and helicopter flights to the upper portal indicate that these activities would produce audible noise levels within known areas of mountain goat habitat. (*See Noise, Chapter 4*). Noise levels at selected receptor sites within mountain goat habitat were projected to range from 42 to 56 dBA. These noise levels correspond to a range of levels typically associated with a quiet home (for the lower values) and an average office (for the higher values).

Audible noise levels at the wildlife receptor sites would be associated primarily with the continuous noise sources associated with Alternative E (dewatered tailings hauling and disposal) and intermittent noise sources such as dam construction (Alternatives B, C, D, and F), helicopter employee transport (Alternatives B, D, E, and F), and haul truck use during construction (for all alternatives). Noise from two of the continuous sources, turbines and mill, are not projected to be audible above background noise levels at the wildlife receptor sites. (*See Noise, Chapter 4*).

Noise levels created by helicopter flights to the upper portal would be higher, ranging from 72 dBA directly under the helicopter flight path to 45 dBA out to 9,000 feet on both sides of the flight path. This noise source would only occur on an intermittent basis since the upper portal helipad would only be used for emergency purposes and occasional operational activities. Flights to the upper portal are more likely to cause avoidance of the area than employee transport flights since the employee transport flights would approach the project site from the coastline.

Increased levels of human activity and noise associated with the development and operation of projects often has the potential for being one of the most significant impacts to wildlife populations. With increased human presence, the potential for wildlife/human interactions ranging from harassment (inadvertent or purposeful) of wildlife to poaching and legal harvest intensifies.

The most common responses of wildlife to noise and human presence are avoidance or accommodation. Avoidance would result in displacement of animals from an area larger than the actual area of habitat disturbance. The total extent of habitat lost as a result of wildlife avoidance response is impossible to accurately predict for most species since the severity of this response varies from species to species

and can even vary between different individuals of the same species. Also, after initial avoidance of human activity and noise producing areas, certain wildlife species may acclimate to the activity and begin to re-invade areas formerly avoided. Reaction of animals to noise varies depending on the intensity of the noise source and whether it is continuous or intermittent. Transient loud noises generally provoke alarm responses, while many animals apparently learn to ignore more constant, lower level noise sources not associated with negative experiences such as being chased (Busnel, 1978).

Although all species may be affected by increased human presence to some extent, big game species are often considered one of the most sensitive to human-related impacts. Numerous studies have looked at the effects of increased human presence and activity on wildlife, particularly big game. Although it is generally assumed that changes in big game movements and distribution are detrimental to individuals and populations, displacement from preferred habitats and increased stress due to human harassment (intentional or otherwise) is difficult to link to changes in reproduction, survival, or any other demographic parameters. If it is assumed that wildlife populations in adjacent undisturbed habitats are at carrying capacity then losses of habitat would result in corresponding reductions in animal populations.

In order to address the extent of potential habitat loss through avoidance, the Forest Service selected black bear and mountain goat for additional model impact analysis. For this analysis influence zones of noise disturbance were projected beyond the areas of direct habitat disturbance. Disturbance distances were selected based on data from the noise analysis for the Kensington Project (*See Noise, Chapter 4*) and existing impact literature for mountain goat and black bear. These zones were selected and developed by Forest Service biologists in consultation with the ADF&G.

Two disturbance zones were used for this analysis, one with a radius of 1.26 miles (for a total area of 5 square miles) and the other with a radius of 2.82 miles (for a total area of 25 square miles). For each action alternative, the disturbance radius was projected from the tailings dam location or the middle of the dewatered tailings disposal area since tailings facility construction would create the highest noise levels. Impacts were derived by reducing Habitat Suitability Index (HSI) values for areas of existing habitat where overlap with disturbance zones occurred. HSI values used in the models range from 0, for unsuitable habitat, to 1, for most suitable habitat.

Within the 5 and 25 square mile disturbance zones, HSI values were reduced by a factor of 0.5 and 0.3, respectively, for mountain goat and by 0.4 and 0.2, respectively, for black bear. These reduction factors represent the percentage of total HSI value subtracted from existing condition HSI values to project impacts associated with noise. The disturbance zone radii and reduction factors were projected based on a coordinated Forest Service and ADF&G biologist review of projected noise levels for the Kensington Project, existing literature, and HSI model information related to disturbance distances.

Results of the disturbance zone analyses for black bear and mountain goat are presented in *Table 4-24, Model Projected Black Bear and Mountain Goat Impacts*. The extent of habitat listed under "No Influence" for each action alternative represents the total amount of existing habitat (with HSI values of 0.1 or greater) for each species within a 25 square mile disturbance zone. The amount of existing habitat varies between alternatives due to the difference in placement of the disturbance zones and the amount of overlap with suitable black bear or mountain goat habitat. Habitat totals listed under "Influence" are the number of acres remaining (with HSI values of 0.1 or greater) after existing HSI values for habitats within the zones of influence are reduced by the appropriate reduction factor. Reductions in the number of animals are based on habitat capability rather than actual population estimates or projections. Predicted losses of habitat and reductions in habitat capability represent worst case projections since the models do not take into account attenuation of noise by terrain and vegetation or the possibility of animal adaptation to noise sources.

As indicated in *Table 4-24, Model Projected Black Bear and Mountain Goat Impacts*,

Table 4-24, Model Projected Black Bear and Mountain Goat Impacts

Alternatives	Black Bear		Mountain Goat	
	Available Habitat (Acres)	Habitat Capability (No. of Animals)	Available Habitat (Acres)	Habitat Capability (No. of Animals)
Alternative B and F				
No Influence	11,259.0	16.2	4,469.1	17.5
Influence	7,935.0	8.1	2,371.4	8.2
Amount Lost	3,324.0	8.1	2,097.7	9.3
Alternative C				
No Influence	11,269.1	16.0	4,560.4	17.5
Influence	7,935.0	8.1	2,371.4	8.2
Amount Lost	3,334.1	7.9	2,189.0	9.3
Alternative D				
No Influence	9,637.5	15.0	2,462.9	9.2
Influence	6,445.3	7.6	1,114.8	3.9
Amount Lost	3,192.2	7.4	1,348.1	5.3
Alternative E - Site A[1]				
No Influence	11,461.7	16.1	4,499.5	18.0
Influence	7,935.0	8.3	2,249.8	8.4
Amount Lost	3,526.7	7.8	2,259.7	9.6

[1]Site A was chosen for modeling of projected impacts since this location is closest to known mountain goat habitat. It is also worst case for black bear since this site occurs in habitat with a higher HSI value for black bear habitat than Site B.

projected impacts for mountain goat and black bear are similar among the action alternatives except for Alternative D mountain goat impacts. This alternative affects the least amount of mountain goat habitat because the Sweeny Creek tailings site is the farthest from modeled and known areas of mountain goat habitat.

With the Kensington Project, increased wildlife losses resulting from increased legal or illegal hunting or trapping in the project area is not anticipated to be a major impact consideration. The Kensington Venture would prohibit trapping and hunting from the project facilities as a condition of employment. In addition, no firearms would be permitted on site. Illegal trapping or hunting of animals also is not expected to increase as a result of project development due to the following reasons: (1) the project site can only be accessed by boat or aircraft and no public access would be permitted; (2) no additional roads would be constructed other than those required for project operation; and (3) employee access to portions of the project area for non-operational purposes would be restricted to foot travel. Foot travel through most of the project area is difficult because of rugged terrain and dense vegetation. Given these considerations it is unlikely that poaching by Kensington employees would go undetected or that illegal harvests in the area by the general public (if any) would increase.

Because of the remoteness of the project site and restrictions on hunting and firearms to be imposed by the Kensington Venture, increases in legal and illegal hunting pressure are expected to be minimal near the project area. However, project related increases in the population of Juneau would result in an overall increase in hunting pressure within ADF&G Game Management Unit 1C. The Strategic Plan for Management of Deer in southeast Alaska 1991 - 1995 (ADF&G, 1991b) assumes that hunting demand will increase in proportion to

population growth. Increased hunting pressure will be highest in areas near Juneau that are readily accessible, such as Douglas Island. Increased hunting pressures on existing game resources would be expected to reduce populations of available game species (e.g., deer) unless management changes such as reducing bag limits or improvements in existing habitat capability occurs.

Potential habitat loss or human disturbance impacts to specific species or species groups are addressed in the following sections.

Mountain Goat. The availability of winter range is thought to be the most limiting factor on mountain goat populations since food availability and quality is reduced during this period. In southeast Alaska, where winter snowfall is typically heavy, areas of old-growth forest near steep slopes with suitable escape cover supply important wintering habitat (Fox et al., 1989). In these areas, dense canopy cover created by old-growth forest intercepts much of the winter snowfall, thus making forage more accessible for mountain goats. (*See Wildlife, Chapter 3*).

Direct habitat disturbances existing within currently mapped ranges of mountain goats (*See Figure 3-23, Mountain Goat Range, and Figure 3-24, Mountain Goat Winter Habitat Capability*) are limited primarily to the two existing portal areas. Most of the surface disturbance associated with the portal areas has occurred as a result of historical mining operations or current exploration activities. Surveys in the forested portions (between 800 and 2,000 feet in elevation) of the slope on which the two portal areas are located indicated some use of this slope by mountain goats, but no evidence of extensive winter use (i.e., heavily browsed shrubs or concentrations of pellets) of this area was documented (Cedar Creek Associates, Inc., 1991). It is possible, however, that past and existing exploration activities at the Kensington Project site have caused changes in historic mountain goat distribution patterns in the area, but the extent to which this may have occurred is unknown.

ADF&G monitoring studies showed that mountain goats did not use the steep, timbered slopes above the Kensington portal during the winter of 1990/1991, although the HSI model identified some of this area as potentially high quality winter habitat. (*See Figure 3-24, Mountain Goat Winter Habitat Capability*). Relocation data indicates that goats which include the mine area within their home range have larger home ranges than mountain goats that did not use the mine area. Also, these goats travelled farther to reach winter range (McCarthy, 1991b). This information is preliminary at this time, and additional data will need to be collected in order to test for significant difference between home range and movement patterns of mountain goats near the mine area and those that do not include the mine area within their home range.

Whether these differences in distribution and movement have had any effect on population size is unknown. Population estimates made by the ADF&G (*See Wildlife, Chapter 3*), however, indicate that Lions Head mountain goat population numbers are near the maximum population size predicted by the habitat capability model for this species. Additional data collected in succeeding years will be evaluated by Forest Service and ADF&G biologists to assess future impacts and validate model predictions for this species.

Research has indicated that human activity can displace mountain goats from portions of otherwise undisturbed habitat. Chadwick (1973) found that mountain goats abandoned habitat, at least temporarily, as a result of road building activities in western Montana. In Glacier National Park, Singer (1975) found that mountain goats demonstrated some habituation to noise and human disturbance, but loud construction activities caused mountain goats to avoid or restrict their use of previously used habitats.

Foster and Rahs (1983) analyzed mountain goat response to hydroelectric exploration activities using aircraft and found that a buffer zone of a minimum radius of 2 kilometers (1.2 mi) was required to prevent an overt mountain goat response to human activity. This study indicated that mountain goats did not habituate to human activity and that disturbance factors appeared to be additive.

In western Montana, Joslin (1986) found that mountain goats redistributed themselves in response to seismic energy exploration activities (including helicopter use) but did not abandon home ranges. Jacobsen and Loewen (1980, as cited in Joslin, 1986), however, found that blasting for avalanche control caused mountain goats to abandon winter range at Lake Louise in Banff National Park, Canada. In Joslin's study, mountain goats moved to a point where topographic relief shielded them from direct line-of-sight of exploration activities. Joslin also correlated declines in female adults and kids to peaks in seismic exploration and postulated that these declines were the result of increased stress from exploration activities.

Based on these studies, it is expected that mine construction and operation, and possibly helicopter use, would displace mountain goats from at least portions of currently occupied habitats. This displacement could force animals into less than optimal habitats, increase stress on the population, and eventually result in population declines, especially if animals are displaced from key wintering areas. Displacement would be expected to last for the life of the mine, although some studies indicate that some habituation to human activity may occur over time (Penner, 1988; Singer 1975).

Distances mountain goats may be displaced from the Kensington Project are unknown. Radio-collar studies of mountain goats being conducted by the ADF&G (in cooperation with the Kensington Venture) would address potential displacement if project development occurs. Displacement distances recorded by Foster and Rahs (1983) for mountain goat movement away from temporary exploration camps ranged from 1 to 3 kilometers (0.6 to 1.8 mi). Similar displacement distances could be expected for the Kensington Project, but the presence of rugged topography and the density of forest vegetation between the project area and occupied mountain goat habitats may lessen the magnitude of actual displacement distances.

For the purposes of impact assessment in this analysis, mountain goat habitat capability was reduced out to approximately 3 miles from the tailings structure. (*See Table 4-24, Model Projected Black Bear and Mountain Goat Impacts*). Reductions in habitat capability were similar for Alternatives B, C, D, and F, ranging from nine to ten mountain goats. Alternative D was projected to have the least impact on mountain goats, with a reduction in habitat capability of five animals.

There is also the potential for disturbance to mountain goat habitats from employee transport flights to and from the Juneau airport and the mine site. Helicopter transport to and from the project site in suitable weather would generally follow the Montana Creek and South Fork of Cowee Creek drainages, cross the mouth of Berners Bay, and proceed overland near the coastline in the vicinity of the project area. (*See Figure 2-13, Helicopter Flight Path*). These flights would maintain an elevation of 2,000 feet or higher when permitted by weather. At this elevation noise levels along the flight corridor would be similar to those predicted for flights from Comet Beach to the upper portal. (*See Noise, Chapter 4*). The overland portions of these flights would not pass near areas of steep topography and rock outcrop preferred by mountain goats. Mountain goats in areas of occupied habitat, such as Stoller Mountain, could be exposed to noise levels of 60 dBA or less for a very short duration at the distance flights are projected to pass by.

When low cloud cover does not permit flights along the preferred flight path specified above, lower level helicopter flights adjacent to the mainland coastline may be followed for employee transport. These flights would be far enough from occupied goat habitat that existing mountain goat populations would not be exposed to any measurable increase in noise levels.

There would be an average of 12 helicopter round trips per week year round to transport employees. This represents only a small incremental increase in air traffic along Lynn Canal when compared to other flights from Juneau to Skagway or Haines that fly over the project site. It is not expected that the small amount of additional noise created by the Kensington flights would have any measurable effects on mountain goat populations in proximity to the flight corridor.

The Forest Service monitored mountain goat responses to fixed-wing and helicopter flights in the area of the Kensington and Jualin exploration areas during the summer of 1991. The preliminary results of this study indicate that mountain goat populations in areas near the transportation flight path are at sufficient distance to preclude any adverse reactions to helicopter use.

Moose. Observations of moose and moose sign indicate that a few moose use the project area during the summer months. Moose occurrence within the project area appears to be associated primarily with the Slate Creek Lakes, Independence Lake, muskeg, and avalanche chute areas where riparian vegetation has developed. Disturbances in these areas or habitats would be expected to have the most detrimental effect on moose summer use of the project area.

Although moose use of the project area is relatively minor, project development could displace moose from a few small areas of previously suitable habitat. Moose appear to generally avoid habitats within 1 to 2 kilometers (0.6 to 1.2 miles) of human activity (Beak Consultants, 1979; Hancock, 1976). Project development could displace moose from a somewhat larger area by precluding moose movement from the Berners Bay area to the Independence Lake area. Project activities are not expected to affect moose use of habitats around Slate Creek Lakes. Minor changes in moose distribution within the project area are not anticipated to result in any long-term impacts to the Berners Bay moose population.

Black and Brown Bear. Numerous studies have documented brown and black bear avoidance of roads and other energy or mineral exploration activities (Pelton, 1982; Tietje and Ruff, 1983; Zager et al., 1983; McLellan and Shakleton, 1988; Harding and Nagy, 1977; Schoen and Beier, 1989). However, observed demographic changes resulting from avoidance behavior are often minimal for bears, especially where suitable security cover is available (McLellan and Shakleton, 1988; Zager et al., 1983). In southeast Alaska where security cover is provided by dense rain forest, brown bear avoidance of roads and mine development areas on Admiralty Island was less than that determined for similar disturbances in the Rocky Mountains where disturbance areas occurred in more open habitats (Schoen and Beier, 1989).

Black bear responses to mining have not been monitored in southeast Alaska, therefore, potential for impacts is uncertain, and distances that black bears may be displaced from the Kensington Project are unknown. Radio-collar studies of black bears initiated by the ADF&G (in cooperation with the Kensington Venture) in late summer 1990 would address demographic changes to the local black bear population resulting from potential displacement if project development occurs. Preliminary results from winter 1990/1991 black bear relocation surveys indicate that one black bear winter denned approximately 200 feet above the lower Kensington exploration portal (McCarthy 1990; 1991b).

For the purposes of impact assessment in this analysis, black bear habitat capability was reduced out to approximately 3 miles from the tailings structure. (*See Table 4-24, Model Projected Black Bear and Mountain Goat Impacts*. The corresponding reduction in habitat capability was approximately eight black bears for all action alternatives.

In many instances, the direct effects of energy or mineral exploration and development are probably insignificant in comparison to the secondary effects of increased human access and habitation (Wheeden, 1970, as cited in Peek et al., 1987; Schallenberger, 1977). Limited displacement of bears in conjunction with the fact that bears (especially black bear) can habituate to human presence (Archibald et al., 1986; Pelton, 1982) increases the potential for bear/human interactions and bear mortality through illegal or defense-of-life-or-property kills. One of the major problems associated with human development and bears is waste disposal. Human garbage is cited as one of the major contributors to bear attacks on humans and the reason that many garbage habituated bears must be destroyed (Herrero, 1985).

Bear/human interactions and resulting bear mortalities can be minimized by daily garbage incineration and an effective bear/people management plan as evidenced by the Greens Creek Mine development on Admiralty Island

where brown bear populations are relatively high (Schoen and Beier, 1989). Plans by the Kensington Venture to incinerate garbage and implement a bear/people management plan in cooperation with the ADF&G should also minimize the risk of "problem bears" at the Kensington Project site.

Gray Wolf. Gray wolves are not common within the project area and project development is not expected to have a significant effect on regional gray wolf populations. Of the larger mammals present in the project area, wolves are expected to be the least affected by human activities. Chapman (1976, as cited in Bromley, 1985) reported that wolves were generally not disturbed by humans further than 0.5 mile in open areas and 0.25 mile in forested areas. Klein's (1973, as cited in Bromley, 1985) studies of moose, caribou, grizzly bear, and wolf responses to low-flying helicopters and fixed-wing aircraft indicated that wolves appeared the least disturbed and showed evidence of habituation.

Gray wolves are wide-ranging and their distribution is tied primarily to that of their principal prey in the region (deer, moose, and mountain goat). Mountain goat and moose represent their principal prey within or near the project area. If displacement of mountain goat and moose make these species more vulnerable to wolf predation, wolf populations could actually increase in the vicinity of the project area.

In Alberta, Canada, gray wolves used the refuse dump of an oil exploration camp for an alternative food source (Fuller and Keith, 1980). If garbage at the Kensington site is not disposed of properly, gray wolf presence in the project area could increase with resulting increases in gray wolf/human interactions.

Nesting Birds. Disturbance in beach fringe areas could also eliminate potential nesting use of these areas by shorebirds and Vancouver Canada geese. Physical disturbances to shoreline habitats would occur with the barge marine terminal (all action alternatives) and the ferry marine terminal (Alternative C). Vancouver Canada geese nest and rear their young in old-growth forest habitats adjacent to surface water (Lebeda and Ratti, 1983). In the project area, nesting usually occurs in marine beach fringe habitats since upland freshwater lakes and adjacent habitats are usually still covered by ice and snow during the early portion of the nesting period (Isleib, 1990).

Shoreline habitats at or near potential disturbance zones are characterized by cobbly beaches. Hemlock/spruce forest occurs adjacent to beach/intertidal areas except where separated by a narrow strip of grassy beach fringe habitat. The lack of cliffs or broad intertidal areas limits potential nesting habitat for most waterbirds that could breed in the area. Black oystercatcher is one of the few species that could potentially breed in shoreline habitats in the project area. Spring 1991 (May through June) waterbird monitoring surveys did not record any concentrations of potential shoreline nesting species near potential disturbance areas (King, 1991). The spring waterbird monitoring surveys also did not record any Vancouver Canada geese in Lynn Canal near the project area or within a mile of Slate Creek Cove (King, 1991). Therefore, impacts to potential shoreline nesting habitats of Vancouver Canada goose and other waterbird species is expected to be minimal.

Loss of forested habitats could eliminate nest sites and reduce the reproductive potential of forest nesting songbird and raptor species (e.g., northern goshawk, great horned owl, and other owl species) in the area.

A habitat feature of importance for woodpeckers and some songbirds is snags. Snags provide an important source of nest holes for cavity nesting species such as the hairy woodpecker and winter wren. Snags are primarily associated with old-growth stands, and the clearing of old-growth forest would represent a long-term loss of this habitat feature.

Loss of old-growth forest may also reduce the amount of potential nesting habitat of the marbled murrelet since this species is known to nest in old-growth trees as far as 20 miles inland. Spring 1991 waterbird monitoring surveys recorded 11 and 39 murrelets within 1 mile of Point Sherman in May and June, respectively.

Loss of habitats adjacent to Sweeny Creek or Sherman Creek by tailings impoundment construction would eliminate the potential for nesting by harlequin duck in these areas. Harlequin duck was one of the more common duck species recorded near the project area by the spring 1991 waterbird surveys (King, 1991).

Bald eagles are known to nest in old-growth forest along the shoreline near the Kensington Project area (*See Figure 3-27, Bald Eagle Nest Sites*). No bald eagle sites would be lost to direct disturbance from any of the action alternatives. There is the potential, however, that project construction and operation or helicopter use could disturb nesting activity or preclude bald eagle use of a nest site. In order to prevent disturbance of bald eagle nest sites in Alaska, the USFWS and Forest Service have developed an Interagency Agreement (May 15, 1990). The agreement requires the establishment of a 330-foot management zone around a nest site. Disturbance activities within this zone are restricted during the nesting season (March 1 to May 31 and June 1 to August 31, if there is evidence of nesting activity). In addition to the 330-foot management zone, the agreement applies restrictions to blasting within 0.5 mile and to repeated helicopter flights within a 0.25 mile of bald eagle nests.

For all action alternatives except Alternative C, no disturbance activities would occur within 330 feet of bald eagle nest sites. Subsequent sections evaluate the proximity of alternative-specific disturbance sites to known bald eagle nest sites.

Helicopter use and construction, (including blasting) near the coastline may disrupt bald eagle and waterbird nesting use of these areas. Operation of oil exploration drill rigs and helicopters have been shown to clear geese from an area of 1.5 mile radius (Barry and Spencer, 1976, as cited in Bromley 1985; Berger, 1977). Reduced nesting success, nest abandonment, and loss of eggs has been demonstrated for waterfowl, shorebirds, and bald eagles in response to aircraft disturbance, especially by helicopters (BLM, 1976).

Employee transport helicopter flights would maintain an elevation of 2,000 feet or greater except when prevented by weather. In addition, the closest bald eagle nest site (near the mouth of Sweeny Creek) to the proposed heliport is nearly 2,500 feet (or 0.5 mile) away. Since helicopter operation would occur outside of the 0.25 mile restriction specified by the Interagency Agreement, impacts to bald eagle nests by helicopter operation is not expected. The helicopter flight path also is not expected to impact waterbird nesting use of shoreline habitats except where it approaches the Comet Beach area for landing. As indicated previously, shoreline habitats in this area are unsuitable for nesting use by most waterbird species. As a result helicopter disturbance of nesting waterbirds would be negligible.

Blasting related to construction activities does have the potential to disturb bald eagle nest sites. As indicted in the alternative-specific impact comparisons that follow, several bald eagle nest sites occur within 0.5 mile of proposed project facilities. The current Interagency Agreement between the Forest Service and USFWS would place timing restrictions on this activity depending on which alternative is implemented. These restrictions should prevent blasting disturbance of bald eagle nest sites.

Threatened and Endangered Species. No direct loss of critical or important habitat for any federally or State listed threatened and endangered, proposed, or candidate wildlife species would occur with project development. The American peregrine falcon occurs in Lynn Canal only during migration and is not expected to be affected by project development. The Peales' peregrine falcon is non-migratory and is known to nest in southeast Alaska. This species is not listed as threatened or endangered, and no evidence of nesting activity was observed near the project area.

Increased human activity in the form of additional marine boat traffic from Juneau to the project site has the slight potential to affect whale movement and distribution within Lynn Canal. Potential effects to whales could include displacement of whales due to vessel traffic and noise and physical harm to whales resulting from inadvertent whale/vessel collisions. Studies in Glacier Bay on the interaction between vessels and humpback whales (Baker

et al., 1982; Baker et al., 1983) indicated that whales were least affected by vessels travelling at constant and relatively slow speeds.

No humpback or other whale concentration areas are known in the vicinity of the project area, although the humpback, killer, and minke whale may occasionally occur offshore in Lynn Canal. Humpbacks are known to occasionally feed near Point Sherman and are observed in Berners Bay. (*See Wildlife, Chapter 3*). The Kensington Venture would use vessels primarily for transport of construction materials, equipment, and bulk supplies. These supplies would typically be shipped by barge in Lynn Canal. Barges travel at slow and relatively constant speeds. This added vessel traffic is not expected to have any noticeable effect on the distribution or behavior of whales within Lynn Canal.

Although no concentrations of Steller sea lions are known to haulout or pup in the project area, incidental observations indicate that a small number of sea lions haulout in the vicinity of Slate Creek Cove and along the coast between Point St. Mary and Point Sherman. Steller sea lions also are known to feed in the vicinity of Point Sherman. Low-level helicopter flights or ferry boat use in the vicinity of these haulout sites could have the potential to cause temporary abandonment of these sites by Steller sea lions.

The helicopter contractor to the Kensington Venture has indicated that the helicopter flight path would avoid coastal areas except in the immediate vicinity of the project landing site. In addition, helicopter flights would maintain an altitude of at least 2,000 feet whenever weather and safety considerations permit. Ferry traffic (associated with Alternative C) and barge traffic, in order to avoid potential shoreline obstructions, would not be expected to pass within 1,000 feet of sea lion haulouts. Disturbance to sea lion haulouts along marine vessel and helicopter flight travel corridors is, therefore, not expected to occur.

Aircraft flights or boat traffic also are not expected to have any noticeable effect on sea lions feeding or travelling through the area. Potential impacts to humpback whale and Steller sea lion are discussed in greater detail in *Appendix B, Biological Assessment.*

Contaminated Surface Water

With the onset of the widespread use of cyanide extraction of gold by the mining industry, the deaths of several thousand vertebrates (birds, mammals, reptiles, and amphibians), especially birds, have been documented at mines using this technique (Clark and Hothem, 1991). Deaths have been linked primarily to wildlife ingestion of cyanide-laced water. Although, other water quality factors such as high pH and levels of heavy metals may also contribute to mortality. The most dramatic losses documented for cyanide process tailings impoundments have occurred at mines reporting cyanide levels in tailings waters above 100 ppm (100 mg/l), especially where the contaminated water source is far removed from other sources of surface water.

Greatest concern has focused on migratory birds because they are federally protected by the Migratory Bird Treaty Act and because the greatest number of mortalities have been reported for these animals. Mining companies with wildlife mortalities have been working closely with State and federal agencies in the lower 48 states over the last few years to correct the problem. Currently, the most effective methods to eliminate kills of migratory birds and other species have focused on either total physical exclusion of wildlife by fencing and netting or chemical detoxification of cyanide before process waters are exposed to the environment (Hallock, 1990).

For many gold mining operations, chemical processes used to remove gold from the ore result in the exposure of cyanide and heavy metal laden waters to the environment via pregnant and barren solution ponds or tailings pond waters. For the Kensington Project, the ore is high grade and gold extraction would be accomplished through a completely enclosed cyanidation process. Therefore, there would be no exposure of pregnant pond, barren pond, or heap leach solutions to the environment. A mixture of tailings and treated process waters would, however, be discharged into the tailings impoundment for Alternatives B, C, D, and F.

For the Kensington Project, wildlife exposure to cyanide and heavy metal contaminated surface water would only occur through direct ingestion of tailings pond water. Exclusion of birds from the Kensington tailings pond by netting would not be practical because of heavy winter snow loads. Therefore, treatment of process waters prior to release into the tailings impoundment is the only means currently available to prevent potential wildlife/toxicity problems in the Kensington tailings impoundment.

As proposed by the Kensington Venture, mill process waters would be recycled to the extent possible. The remaining process waters would be cycled through water treatment, including a cyanide destruct process (alkaline chlorination), to remove the majority of metals and cyanide from solution prior to its release to the tailings pond. Levels of metals and total cyanide in mill effluent after treatment and remixing with tails, not treated by the cyanidation process, are presented in *Table 4-25, Tailings Impoundment Water Quality*.

Levels of total cyanide are projected to range from 0.018 mg/l to 0.69 mg/l with an average of 0.043 mg/l in the tailings pond. These values were calculated on the assumption that no natural degradation of cyanide would occur in the tailings pond. Additional natural attenuation of cyanide would occur within the tailings impoundment. (*See Surface Water Hydrology, Chapter 4*).

Remaining cyanide would consist primarily of iron cyanide complexes which are considered stable and non-toxic. Concern with the toxic effects of these complexes is related to the potential for breakdown of iron cyanides under exposure to sunlight (ultraviolet light) (Mudder, 1990). However, under natural conditions in a stream or pond (i.e., ambient temperature and near neutral pH), iron cyanide is not subject to rapid breakdown (Mudder, 1990). In the event that free cyanide is formed by chemical or photolytic dissociation it would be quickly removed from solution through volatilization.

Table 4-25, Tailings Impoundment Water Quality[1]

Parameter	Tailings Water			EPA Drinking Water Standards MCL
	Low	High	Average	
Aluminum (Al)	**0.284**	**0.956**	**0.621**	NS
Arsenic (As)	**0.005**	**0.010**	**0.008**	0.05
Beryllium (Be)[2]	0.001	0.002	0.002	NS
Cadmium (Cd)[2]	0.003	0.007	0.005	0.005
Chromium (Cr)	**0.020**	**0.039**	**0.031**	0.1
Cobalt (Co)[2]	0.004	0.016	0.010	NS
Copper (Cu)	**0.021**	**0.067**	**0.044**	NS
Lead (Pb)	**0.028**	**0.077**	**0.054**	0.05
Manganese (Mn)[2]	0.111	0.351	0.223	NS
Mercury (Hg)[2]	0.001	0.002	0.002	0.002
Nickel (Ni)	**0.014**	**0.036**	**0.025**	NS
Selenium (Se)[2]	0.046	0.196	0.119	0.05
Thorium (Th)[2]	0.021	0.096	0.067	NS
Zinc (Zn)	**0.018**	**0.057**	**0.038**	NS
Total Cyanide	**0.018**	**0.069**	**0.043**	0.02

MCL - Maximum concentration level
NS - No standard
[1]All concentrations in mg/l.
[2]Concentrations may be overestimated due to use of detection limit for initial calculation.

Metals remaining in trace amounts in mill effluent discharged to the tailings pond would be aluminum, arsenic, chromium, copper, lead, nickel, and zinc. (*See Table 4-25, Tailings Impoundment Water Quality*). Beryllium, cadmium, cobalt, manganese, mercury, selenium, and thorium may also be present in trace amounts. Concentrations given for these metals are likely overestimated since these values were projected from detection limits. The presence of these metals in pilot test samples, if any, was below detection limits.

High pH levels, often associated with other mining operations, would not occur in the Kensington tailings pond. Recovery processes are projected to reduce pH levels in process waters to approximately 7.5 prior to release into the tailings Impoundment.

Safe levels of cyanide and cyanide in association with heavy metals have not been established for water consumed by terrestrial wildlife. The USFWS has initiated research in an attempt to define safe levels of these toxicants in response to recent wildlife mortality problems encountered at cyanide extraction mine operations (Hill, 1991).

Monitoring by the mining industry has indicated that cyanide levels below 50 ppm in tailings pond waters generally do not cause mortality problems in migratory birds (Kay, 1990). However, some mines have documented bird mortalities at cyanide concentrations below this level. The USFWS currently has insufficient data upon which to define a universal toxic threshold for cyanide/metal solutions with respect to birds or other terrestrial wildlife species (Hill, 1991).

Marine and freshwater toxicity criteria are not applicable to terrestrial wildlife since they were developed for aquatic organisms. Paths of toxicant exposure for aquatic organisms include respiration, absorption, and ingestion. For example, copper is highly toxic to aquatic organisms but is generally nontoxic to mammals unless consumed in large dosages (Venugopal and Luckey, 1978). Marine and freshwater criteria would be extremely conservative and unrealistic for terrestrial wildlife since the only mode of exposure for terrestrial wildlife species in the project area would occur through ingestion.

Although safe levels have not been established, human drinking water standards should provide a reasonable margin of safety for terrestrial wildlife. Drinking water standards are based on continuous use of a water source. Since no food or cover will be available to wildlife in the vicinity of the pond area of the tailings impoundment, wildlife use of tailings water would only occur on an occasional basis for obtaining drinking water (birds and mammals) or resting (waterbirds). Consistent use of the tailings pond for water would not be expected since there is an abundance of surface water available to wildlife throughout the project area.

Current EPA drinking water standards are compared to projected cyanide and metals levels in tailings pond waters in *Table 4-25, Tailings Impoundment Water Quality*. As indicated, only lead and cyanide are projected to exceed EPA drinking water standards.

Even though these two parameters are projected to exceed human drinking water standards in the tailings pond, it is unlikely that wildlife occasionally using the pond for resting or drinking water would suffer from any toxic effects. Toxic effects of lead on waterfowl and other wildlife species have only been documented for dosages and/or durations of exposure much greater (Eisler, 1988) than those projected for the tailings pond.

With respect to cyanide, projected levels in the tailings pond are for total cyanide with no natural degradation. Natural degradation is expected to reduce cyanide in the tailings pond to levels below those predicted in *Table 4-25, Tailings Impoundment Water Quality*. Given these considerations, the low levels of metal constituents, and a near neutral pH value for tailings pond waters, no toxic effects to wildlife using the pond would be expected.

There is a slight chance that the low levels of metals present in the tailings pond waters could be bioaccumulated or biomagnified in various tissues of terrestrial animals, such as mink or river otter. Numerous metals, including aluminum, arsenic, copper, lead, nickel, and zinc have been shown to bioaccumulate in different species of mammals (Wren, 1986). However, mercury is the only metal known to exhibit clear biomagnification within terrestrial

food chains (Wren et al., 1983). Levels of mercury are predicted to be below the detection limit in the Kensington tailings impoundment waters (JMM, 1991).

Given the relative low levels of all metals projected for the tailings waters and the fact that no terrestrial species would be expected to use this water on a continuous or long-term basis, it is unlikely that project area wildlife species would bioaccumulate metals to the extent to cause any harmful effects.

The ADF&G has a cooperative agreement with the Kensington Venture to monitor the presence of trace elements in selected aquatic and terrestrial organisms before and during mine development and operation to ensure that wildlife bioaccumulation of metals has not occurred.

One other potential source of wildlife exposure to contaminated surface water sources is the accidental spillage of process chemicals, fuels, oils, or other operational fluids during shipping or handling. The chance for an unanticipated spill to occur in Lynn Canal, Berners Bay, or fresh water sources is unknown. However impacts would be expected to be most significant if spills occur in marine waters, in close proximity to important fishery resources (*See Aquatic Resources, Chapter 4*) or waterbird concentration areas. Waterbird species potentially affected would depend on the location of the spill, season, and weather patterns.

EFFECTS OF ALTERNATIVE B

The extent of habitat, wetland, and old growth disturbance associated with each alternative is summarized in *Soils/Vegetation/Wetlands, Chapter 4*. Most of this disturbance for this alternative would occur in hemlock/spruce forest associations that classify as wetlands (232.8 acres). Only very minor amounts of disturbance would affect muskeg or alder dominated snow slide zones.

Disturbance to the beach fringe would be minimal and limited to the barge docking facility. However, development of the tailings impoundment has the potential to adversely affect the salmon fishery in Sherman Creek. (*See Aquatic Resources - Freshwater, Chapter 4*). Reductions in or loss of the salmon fishery in Sherman Creek would reduce the availability of an important summer food source for black bears. In addition, observations by Kensington personnel indicate that at least one black bear sow uses forested habitats within the proposed impoundment area for cub rearing. With project development, this area would no longer be available for bear use.

Model projected losses of mountain goat and black bear habitats resulting from displacement by human activities are 2,098 acres and 3,324 acres, respectively, for mountain goat and black bear. (*See Table 4-24, Model Projected Black Bear and Mountain Goat Impacts*). With this alternative, noise associated with tailings impoundment construction and helicopter use would be audible at selected receptor sites within known mountain goat range.

The closest proposed development site to a bald eagle nest site is the fuel storage facility. It occurs at least 300 meters (1,000 ft) but less than 0.5 mile away from a nest site. Only very minor areas of old-growth forest would be disturbed within the coastal area preferred for nesting by bald eagles in southeast Alaska. Normal operational activities would not be expected to affect this site during the nesting season. Construction activities, such as blasting, at the fuel storage facility during the bald eagle nesting season could, however, disturb nesting activity. Timing of blasting outside of the nesting season would eliminate this concern.

Development of the marine docking facility would be the only direct disturbance affecting marine habitats. The extent of this disturbance would be relatively minor, and it is not expected to have any noticeable effect on marine mammals or seabirds. The beach area where the docking facility would be constructed and nearby shoreline areas are not used by harbor seals or Steller sea lions as haulout sites. Some minor amounts of nesting habitat for species such as black oystercatcher may be lost to direct disturbance.

There may be a slightly greater chance of spills associated with off-loading of fuel at the Comet Beach marine terminal as compared to

off-loading fuel at the marine terminal in Slate Creek Cove (Alternative C) due to the less protected docking conditions at Comet Beach. Fuel spills in this area could affect a variety and number of seabirds depending on the extent of a spill and weather conditions. (*See Aquatic Resources, Chapter 4*).

EFFECTS OF ALTERNATIVE C

Total habitat disturbance (392 acres) is greatest with this alternative. Increased disturbance associated with this alternative is associated with the development of the access road from Slate Creek Cove to the mine site. Most disturbance would occur in hemlock/spruce forest associations that classify as wetlands (335.9 acres). Only very minor amounts of disturbance would affect muskeg habitats or alder dominated slide zones.

The greatest extent of disturbance to beach fringe areas would occur with this alternative since a temporary marine terminal at Comet Beach and a more permanent docking facility at Slate Creek Cove would be developed. Impacts associated with the tailings impoundment would be the same as those assessed for Alternative B.

Model projected losses of mountain goat and black bear habitats resulting from displacement by human activities are 2,189 acres and 3,334 acres, respectively, for mountain goat and black bear. (*See Table 4-24, Model Projected Black Bear and Mountain Goat Impacts*). With this alternative, noise impacts would be somewhat less than for those assessed for Alternative B since helicopters would not be used for employee transport.

There is a much greater potential for disturbance to bald eagle nesting habitat as a result of the Berners Bay access road and Slate Creek Cove marine terminal. Seven bald eagle nests occur within 330 feet of the alignment of this access road and another four bald eagle nests occur within 0.5 mile of the access road alignment. In addition, one bald eagle nest is located within 330 feet of the Slate Creek Cove docking facility. (*See Figure 3-27, Bald Eagle Nest Sites*). However, as long as restrictions in the Forest Service/USFWS Interagency Agreement regarding bald eagle protection are imposed, impacts to bald eagles would be expected to be negligible. Minor changes in facilities locations and restrictions in construction and blasting schedules would protect bald eagle nest sites.

Additional road development also exposes much larger areas of habitat to the effects of human presence. Increased access opportunities associated with road development in roadless areas have been linked to reductions in bear populations, primarily as a result of increases in legal and illegal hunting pressure (Pelton, 1982). However, public access would not be permitted on the road and Kensington employees would not be allowed to use access roads for hunting.

Development of the marine docking facility in Slate Creek Cove has a greater potential to impact nesting seabirds and waterfowl due to its proximity to estuarine habitats. Ferry traffic and increased levels of human presence could preclude nesting from a much greater area than that directly disturbed by the marine terminal. These activities may also prevent Steller sea lions intermittent use of the cove as a haulout area.

Although the chance for a fuel spill within Slate Creek Cove is somewhat reduced because the waters are more protected, an accidental spill in this area would have the potential to create greater detrimental effects on nesting or wintering waterbirds due the presence of estuarine habitats. Also the additional length of pipeline required to transport fuel from Slate Creek Cove to the mine site increases the chances of overland fuel spills and spills in freshwater and wetland habitats.

EFFECTS OF ALTERNATIVE D

Impacts associated with this alternative would be similar to those assessed for Alternative B except that two drainages (Sherman Creek and Sweeny Creek) would be affected. However, this alternative would disturb the least amount of total surface acreage, 229 acres of which 123.5 acres are classified as wetlands. In addition, modeling indicates that noise impacts to the mountain goat population would be reduced by this alternative since construction of the Sweeny Creek tailings impoundment is

farther removed from areas of known mountain goat habitat. (*See Noise, Chapter 4*).

Model projected losses of mountain goat and black bear habitats resulting from displacement by human activities are 1,348 acres and 3,192 acres, respectively. (*See Table 4-24, Model Projected Black Bear and Mountain Goat Impacts*). As indicated, the magnitude of model projected impacts to mountain goat habitat would be the lowest with this alternative.

EFFECTS OF ALTERNATIVE E

The extent of habitat disturbance is (237 to 242) acres associated with this alternative is less than Alternative B and C but slightly higher than Alternative D. The extent of loss of old-growth forest is the lowest for all action alternatives with the Site B option for Alternative E. Also, wetland loss is second lowest (181.7 to 228.6 acres) with either site option for Alternative E. However, the low potential for wetland reestablishment on the dewatered tailings facility indicates that this alternative has the greatest chance for long-term wetland loss. Impacts associated with this alternative are expected to be generally similar to those assessed for Alternative B except that Sherman Creek would not be directly affected. Projected disturbance to mountain goat habitat would be the greatest with this alternative. Construction of the dewatered tailings disposal facility would generate the greatest extent of continuous high noise levels in closest proximity to known mountain goat habitat.

Model projected losses of mountain goat and black bear habitats resulting from displacement by human activities are 2,260 acres and 3,527 acres, respectively, for mountain goat and black bear. (*See Table 4-24, Model Projected Black Bear and Mountain Goat Impacts*).

EFFECTS OF ALTERNATIVE F

Impacts to wildlife associated with this alternative would be essentially the same as those assessed for Alternative B.

CUMULATIVE EFFECTS

It is unknown if recent and existing exploration activities at the Kensington and Jualin sites have modified mountain goat distribution patterns within existing habitat. If mountain goat distribution has been modified by exploration, additional displacement caused by mine development at either Kensington or Jualin would result in cumulative impacts to the Lions Head mountain goat population.

The greatest potential for cumulative effects relates to increased loss of or indirect disturbance to mountain goat habitat if exploration continues for the Jualin Project or if it becomes an operational mine at the same time as the Kensington Project is in operation. The extent of suitable habitat for the Lions Head mountain goat population is limited in the area. If both projects were to result in losses of suitable mountain goat habitat, then the potential effect on the local mountain goat population could be much greater than that associated with a single project.

If both projects were to develop marine terminal facilities within Slate Creek Cove, there could be a cumulative disturbances to waterbird and Steller sea lion use of the cove. The potential for accidental spills of toxic materials in Slate Creek Cove also would be increased.

Cumulative effects on other wildlife species are expected to be relatively minor due to distances between the two sites and the fact that they occur in two separate watersheds.

SUMMARY

Habitat disturbance associated with Alternative B, E, and F would be confined within one drainage. Alternative E would disturb the least amount of habitat and old-growth forest, but has the greatest projected potential for adverse affects on the Lions Head mountain goat population. Alternative E is the only alternative which would not directly disturb a drainage by tailings disposal.

Alternative D would result in habitat disturbance in two drainages, but would also cause the least amount of total disturbance. Noise impacts are projected to be the least intrusive to the mountain goat population with this alternative.

Alternative C disturbs the greatest amount of upland and wetland habitats. The potential for

disturbance of bald eagle nest habitat, waterbird breeding areas, and small Steller sea lion haulouts in Slate Creek Cove would occur with this alternative. In addition, due to the overland transport distances involved, there is an increased potential for fuel spills and for spills to affect upland and wetland habitats with this alternative.

RECREATION RESOURCES

Potential impacts to recreation can be classified under two general categories: crowding (increased use of area) and introduction of sights and sounds of human activities. It is difficult to quantify the projected increase in use for any development alternative due to the lack of quantified historical use levels. Further, crowding is not perceived uniformly by all people.

EFFECTS OF THE NO ACTION ALTERNATIVE

Impacts on non-resident visitors traveling on cruise ships and ferries are not predicted for this alternative. The recreational experiences of visitors on day cruises and flightseeing trips would not be affected by the No Action Alternative.

Resident users of the Berners Bay area are likely to be impacted by increased levels of use, even in the absence of mine development. The new boat ramp at Echo Cove, with a parking area for 100 vehicles, is likely to stimulate an increase in use as people become aware of the improved facilities.

Recent trail construction at Point Bridget State Park and a proposed recreational cabin would also result in increased use of the area over time.

The increasing popularity of flightseeing and day cruises in the area may create a higher level of use by tourists and could influence the perception of crowding by some resident users.

These potential changes are, however, compatible with the recreational opportunity spectrum classes, semi-primitive motorized (SPM) and semi-primitive non-motorized (SPNM) , designated for the study area. (*See Recreation, Chapter 3*).

EFFECTS COMMON TO ALL ACTION ALTERNATIVES

The project component with the greatest potential to impact recreation use for all alternatives is transportation. The transportation choices may affect both non-resident and resident users. Increased air and barge traffic to the site have the potential to increase noise and human activity above the scale expected by recreationists.

The noise and activity associated with transportation is most likely to directly affect recreationists who visit the area on foot or in kayak, canoes, or small motor boats. Some alternatives have different impacts which would be discussed separately.

Cruise ship passengers would not be affected by noise generated by barges and helicopters. The transportation activities may draw the attention of shipboard observers. Visitor attitudes about transportation activities are likely to be split, with some perceiving them as negative and others interested in the operation.

Noise generated by other aspects of the mining operation would create a potential negative impact on recreationists in the SPNM portions of the site. Noise studies show that recreationists in Berners Bay would not be affected by noise from mining operations (*See Noise, Chapter 4*).

The visibility of project components may impact recreationists by introduction of human activities into an area classified as SPNM. All alternatives affect the visual quality of the area. Although the area has been mined previously, most signs of human use have disappeared.

Impacts on the biological resources, especially fish and wildlife, have the potential to affect recreational users of the area. Any impacts likely would not affect tourists, but could alter the hunting and fishing experiences of a small number of City and Borough of Juneau residents who may have pursued these activities near the project area in the past. (*See Wildlife and Aquatic Resources, Chapter 4*).

Population Increases due to project development would likely result in increased hunting and sportfishing pressure near the project area and in the region. It is impossible to accurately predict numerical increases largely because current data on hunting and fishing licenses maintained by the ADF&G are incomplete. A reasonable assumption would be that resident hunting and fishing pressure would increase in proportion with project induced population Increases. Accessible hunting areas such as Douglas Island and Admiralty Island could experience noticeable increases in hunting pressure thereby leading to a decrease in the perceived quality of hunting experiences for some persons.

According to The Strategic Plan for Management of Deer in southeast Alaska 1991 - 1995 (ADF&G), hunter demand for deer in Game Management Unit 1C currently exceeds existing populations, and hunter success is low due to low population densities of deer. With increased hunting pressure the existing four deer bag limit may be reduced.

All alternatives would affect the potential for recreational use of the Comet Beach area. Recreationists would be displaced due to transportation and mining activities.

The new boat ramp facility at Echo Cove has the potential for increasing recreational use in the general area. It is, however, difficult to quantify the potential displacement effects.

EFFECTS OF ALTERNATIVE B

The proposed mine site is on the Alaska Inland Passage route, a high visibility area that had 225,000 visitors in the traffic summer of 1990 (Lendaro, 1991). Transportation activities associated with this alternative may draw attention to the mining operations, however, this is likely to have a small impact on the shipboard visitor's experience.

There is a greater potential for helicopter transport of employees to affect recreational users of Berners Bay, but these effects are difficult to qualify. Helicopter transport impacts to recreationists would be limited, to some extent, by the flight path (*See Figure 2-12, Helicopter Flight Path*) and by the fact that no employee transport flights are proposed for the weekends. (*See Transportation, Chapter 4*).

The general mine development area can only be accessed by boat, float plane, or helicopter. There is no indication that the proposed operations and tailings disposal areas have received significant recreational use in the recent past. Some limited hunting for mountain goat and black bear, however, does take place in the general area. Mining activities would occur in an area classified SPNM. With recreational use of the area increasing, some recreationists could be displaced, but low historical levels of use make it likely very few persons would be displaced from traditional use of the project area. Effects on wildlife in the Sherman Creek drainage may indirectly affect hunting experiences in the general vicinity.

EFFECTS OF ALTERNATIVE C

All of the impacts associated with Alternative B would apply. Additionally, there would be impacts resulting from the construction and use of a marine terminal at Slate Creek Cove in Berners Bay, and from the 8.5 mile long access road from the terminal to the mine site.

Impacts on tourists are expected to be negligible. Recreational users of Berners Bay are expected to be more directly impacted. A survey of study area users shows that a number of people use the Slate Creek Cove area for recreational activities including picnicking, camping, and wildlife watching (Beck & Baird, 1990). Some users would be displaced by construction of a marine terminal in Slate Creek Cove.

Slate Creek Cove is visible from most of Berners Bay. Although the terminal site is classified SPM, this alternative would introduce ferry and barge transport traffic into Berners Bay. Under this alternative, workers would take the ferry to the site daily (approximately 32 round-trips per month). Supplies would be delivered by barge once a month. Diesel fuel and LPG fuel would be delivered by barge bimonthly. Supply and fuel barge trips would average approximately 0.75 trip per week during operation.

Barge and ferry traffic would be restricted to the west side of Berners Bay. Ferry travel time

within Berners Bay would be approximately 10 minutes for each trip to and from the Slate Creek Cove terminal. Barge travel time within Berners Bay would range from 30 to 45 minutes for each leg to and from the Slate Creek Cove Terminal. Noise and activity associated with this marine traffic would alter the recreation experience in Berners Bay. The noise and dust associated with the access road from Slate Creek Cove would increase the amount of visible and audible human activity on the peninsula in an area classified SPNM.

EFFECTS OF ALTERNATIVE D

Many of the potential impacts of this alternative are similar to those from Alternative B. All activities would occur on the Lynn Canal side of the peninsula, however, they would be located in both the Sherman and Sweeney Creek drainages. There is no evidence of recreational use of the Sweeney Creek drainage. However, it is classified SPNM. Traditional users would be displaced in both the Sherman and Sweeney Creek drainages. There would be some increase in noise in Bridget Point State Park as a result of helicopter operations. The noise increase would be mostly heard during the week. No flights would be scheduled for weekends.

EFFECTS OF ALTERNATIVE E

This alternative is similar to Alternative B in that impacts would be concentrated in the Sherman Creek drainage. As mentioned in *Visual Resources, Chapter 4*, this alternative would have the highest visual impact.

EFFECTS OF ALTERNATIVE F

Alternative F would have the same effects as Alternative B.

CUMULATIVE EFFECTS

With the potential for combined population increases resulting from the potential start-up of mining operations (AJ, Jualin) in the Juneau area, it can be predicted with certainty that recreational use of the study area, and especially Berners Bay, would increase. Increased loss of recreational opportunities in undeveloped areas is also expected (i.e., hiking along Sheep Creek for the AJ; camping in Slate Creek Cove for Alternative C, Kensington Project). However, it is not possible to quantify projected increases. Predictive models are not available to estimate correlations between the start-up of a mining operating and increases in boat registration or hunting and fishing licenses. With the start up of more than one new mine in the region, it is possible that increased hunting and fishing pressure could eventually result in reduction in current fish and game bag limits established by the ADF&G.

The Jualin project would increase total use of Berners Bay waters. Mine related traffic would regularly use the bay for access. It is not possible to predict traffic levels associated with the Jualin Project.

SUMMARY

The proposed alternatives are projected to have similar impacts on non-resident and resident recreational experiences, with a few exceptions. Alternative C would result in direct impacts to recreational users of Berners Bay by introducing additional sights and sounds of human activities. This alternative would displace some users from dispersed camping and other activity sites in the Slate Creek Cove area. The access road from Slate Creek Cove has the greatest potential to affect shoreline recreational use of the area. Project components along shorelines have the potential to directly affect users because of the number of recreationists who access the general area in boats. The shorelines within Berners Bay, all classified SPM, are where most recreational use occurs.

Alternative D potentially could affect users and biological resources in two rather than one drainage. There is no evidence, however, of recreational use of either drainage.

Tourists, especially those on cruise ships and ferries, would be affected indirectly, if at all, by any of the alternatives.

CULTURAL RESOURCES

This section describes potential impacts of the project alternatives to cultural resources in the project area.

EFFECTS OF THE NO ACTION ALTERNATIVE

Historical and archaeological resources would remain unchanged. Any known or unknown resources would not be affected under this yaction. Other federal undertakings may be required to secure their preservation. Continued exploration under existing permits would require actions for each new permitted exploration on a case by case basis. No impacts would be associated with continued exploration activities.

EFFECTS COMMON TO ALL ACTION ALTERNATIVES

It is unlikely that any adverse effects would occur to cultural resources. The historic remains at the old mine site have been determined not eligible for inclusion in the National Register of Historic Places; further use of the historic area would not constitute impact. However, the presence and nature of prehistoric or nonmining historic resources have not been fully determined. In the unlikely event that prehistoric or historic remains are located, work would stop and the resource evaluated in accordance with Sec. 106 of the National Historic Preservation Act.

Additional testing of resources prior to construction would determine the presence or absence of archaeological sites. Mitigation of any discovered resource can take place under a State, federal, and certified local government accepted mitigation plan, thus eliminating the potential for negative impacts to cultural resources.

Many Tlingit sites are recorded or reported for the greater Berners Bay area and these are accessible by walking along the coast or by boat. Secondary effects of increased site visitation may result in increases in pedestrian traffic, potential for damage to fragile resources, and possible unauthorized removal of resources. Secondary effects to known or reported cultural resources can be reduced through instruction of mine personnel about the sensitive nature of archaeological sites. Operating policies including "off limits" requirements to cultural resources also may reduce secondary effects if cultural resource sites are located near the project.

EFFECTS OF ALTERNATIVE B

It is unlikely that any adverse effects would occur to cultural resources. The historic remains at Comet Beach and the mine site, previously discussed in Impacts Common to all Action Alternatives, have been determined not eligible for inclusion on the National Register of Historic Places. Further use of these areas would not constitute impact. However, the presence and nature of unknown prehistoric resources have not been determined here. Prehistoric remains that may be located here could be impacted if no further cultural resources reconnaissance, testing, and mitigation, takes place. It is unlikely that prehistoric sites do exist, although one untested raised beach or terrace to the north of the mouth of Sherman Creek may contain prehistoric or protohistoric resources.

Additional testing and mitigation would take place as indicated in Impacts Common to All Action Alternatives.

EFFECTS OF ALTERNATIVE C

Site 49-JUN-013, could potentially be impacted by this alternative. The presence and extent of the site remains unknown.

The direct effects to the Mine Site, Comet Beach, and Sherman Creek would remain the same as for Impacts Common to all Action Alternatives and Impacts to Alternative B.

Additional testing and mitigation would take place as indicated in Impacts Common to All Action alternatives.

EFFECTS OF ALTERNATIVE D

It is unlikely that prehistoric sites exist, although one raised beach or terrace at the mouth of

Sweeny Creek could potentially contain prehistoric resources. Unrecorded historic resources may also be found at the same location.

The direct effects to the Mine Site and Sherman Creek would remain the same as for Impacts Common to All Action Alternatives and Impacts to Alternative B.

Additional testing and mitigation would take place as indicated in Impacts Common to All Action Alternatives.

EFFECTS OF ALTERNATIVE E

The direct effects to the old mine site, Comet Beach, and Sherman Creek would be as described under Impacts Common to All Action Alternatives and Impacts to Alternative B.

Additional testing and mitigation would take place as indicated in Impacts Common to All Action Alternatives.

EFFECTS OF ALTERNATIVE F

Alternative F would have the same effects as Alternative B.

CUMULATIVE EFFECTS

The State of Alaska, like other places throughout the nation and world, has witnessed an accelerating loss of cultural resources from natural erosion, unauthorized removal of resources, development without cultural resource stipulations, and careless damage from unknowing persons. Additionally there is little action that can take place to save resources that have already been severely deteriorated through the ravages of time and the elements.

The resources of the proposed project area are, for the most part, well documented. It is unlikely that additional resources exist, but the aforementioned places where prehistoric or protohistoric remains could be found may require some additional reconnaissance, testing, and protective or removal action. The potential cumulative direct or secondary effects to any significant cultural resources, if unmitigated, are the resultant loss of a resource base that is finite and non-renewable. Mitigation of any discovered resource can take place under a State, federal, and certified local government accepted mitigation plan, thus resulting in no cumulative impact.

SUMMARY

It is unlikely that any adverse effects would occur to cultural resources. The historic resources have been documented. It is unlikely that prehistoric sites exist, although limited ground truthing and testing may be required to confirm the presence or absence of cultural resources at some specific locations within the proposed project area.

Final selection and acceptance of the preferred alternative would dictate where additional cultural resource confirmation work should take place. Mitigation of any discovered resource can take place under a State, federal, and certified local government accepted mitigation plan, thus resulting In no cumulative impact to cultural resources.

VISUAL RESOURCES

This section presents the projected impacts to visual resources. Critical viewpoints are those viewpoints from which most people would view the site. For this project, Alaska Marine Highways routes and other ship routes in Lynn Canal are the critical viewpoint. Visual impacts have been assessed from viewpoints approximately 1 mile offshore in Lynn Canal, at elevations above the water from 20 to 100 feet. (*See Figure 4-6, Critical Viewpoints Map*). Commuter airlines fly over the site, but emphasis on critical viewpoints is placed on the view from the water, since cruise ships carry a much larger number of people and these people would have a much longer viewing period of the project area (approximately 10 minutes). The Forest Service's established Visual Quality Objectives are used as a measure of visual impact (*See Visual Resources, Chapter 3*). In the Lynn Canal viewshed, the distance zone is middleground for all project components.

The topography in the Kensington Project area is a mixture of relatively subdued hills with

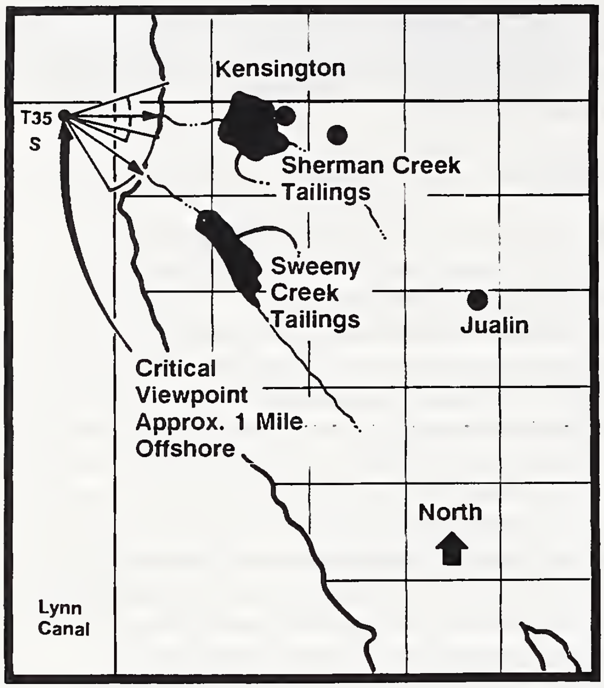

Figure 4-6, Critical Viewpoints Map

parallel drainages following regional geologic strikes to the south and mountain slopes with steep gradients in excess of 75 percent composed of massive cliff forming bedrock peaks above and to the north of the project.

The visibility of the site varies by season. Low clouds, fog, and low light conditions in the late fall and winter reduce visibility of the site. Snow cover alters the visibility of some elements in the landscape. Low visibility and snow cover correspond with seasons of reduced viewer numbers. The visual resource analysis was made assuming no impaired visibility due to weather conditions and no snow cover.

EFFECTS OF THE NO ACTION ALTERNATIVE

If the Forest Service were to deny the permit for operation, there would still be some visual impacts incurred from the existing exploration activity. Although the area has been mined previously, most signs of human use have disappeared. The existing impacts include the adit, clearing below the lower adit, and a small waste rock pile. The road from the beach to the lower portal is visible, as are portions of two buildings near the beach. The existing activities along the beach are in an area designated as distinctive Variety Class A and highest Sensitivity Level 1, with a Visual Quality Objective of Retention. The access road and mining activities are in an area with the highest sensitivity level, but common Variety Class B. The Visual Quality Objective is Partial Retention. The existing impacts are of relatively small scale and the Visual Quality Objectives could be met.

EFFECTS COMMON TO ALL ACTION ALTERNATIVES

Some project components would have the same visual impacts for all alternatives.

Marine Terminal

Each alternative except Alternative C, includes a marine terminal complex on and near Comet Beach. The components include the barge landing area, fuel storage/laydown, heliport, explosives storage, and access road. The primary visual impacts associated with these elements include clearing vegetation and introduction of structures. Most of the structures are low profile and would not introduce form or line impacts. The exception is the LPG storage tank, a 76 foot diameter sphere. Due to the amount of clearing in the fuel storage/laydown area and to the sparser nature of the vegetation closer to the shore, the tank could be visible against the landscape, however, proper color selection for painting would reduce the potential contrasts.

The structures at water's edge, including a possible fuel unloading trestle and barge landing, are not massive. The visual impact would result from breaking the unity of the shoreline by the structures. Color and texture contrasts from buildings are possible, but could be reduced by proper color selection to match background landscape.

The beach area is designated as distinctive variety class with highest sensitivity level and a Visual Quality Objective of retention. That objective extends in a band from the beach inland up to several hundred yards, depending on the topography. The retention Visual Quality Objective probably cannot be met during operation, but should be attainable after closure when structures are removed and reclamation has occurred.

Access Road

The length of the access road varies by alternative. All access roads would be constructed with a 30-foot surface width and turnouts. The common visual impacts of road construction result from clearing of vegetation and introducing a visible line of contrast in color and texture between the cleared area and the adjacent, uniform appearing vegetation. In most forested areas, access roads would not be visible from Lynn Canal, although road cuts may create visual breaks in the vegetation canopy. In areas of more open vegetation or where roads traverse elevated portions of terrain, cuts and fills and the road surface may be visible, creating a contrast in color between newly exposed soil and surrounding ground cover.

Most of the access roads traverse an area designated as Variety Class B, with Sensitivity Level 1. The Visual Quality Objective is Partial Retention. The contrasts introduced by the road would be visually subordinate to the characteristic landscape and therefore would meet the Visual Quality Objective.

Main Facility

The process area would require the largest amount of clearing and cut and fill of any of the components common to all alternatives. Some of the buildings would be approximately 80 feet tall and about 140 feet long from north to south. The buildings would be strung together along an excavated bench. The power plant would have five 60-foot tall stacks. None of the buildings or the stacks would require aircraft warning lights since a height of 200 feet is not exceeded and the site is more than 20,000 feet away from any established airport (Ninger, 1991). The mill facility area is the same in all alternatives. The visual impacts vary by alternative associated with the tailings disposal component affects on visibility.

The process area occurs in a Variety Class B, Sensitivity Level 1 area with a Visual Quality Objective of Partial Retention. The process area, on its own, may meet the Visual Quality Objective if foreground screening by vegetation were maintained. Depending on the tailings disposal option, there are cumulative effects in some alternatives of the process area and tailings disposal which affect the likelihood of meeting the Visual Quality Objective.

Potential visual impacts from production activities would be due to fugitive dust and emissions from the power plant, exhaust portal, and other fuel burning equipment. (*See Air Quality, Chapter 4*).

The employee camp would not be visible from the critical viewpoints due to screening by topography and vegetation.

The project would be visible at night due to lights on buildings and exterior work and storage areas. Lightning would be directed inward to reduce glare in Lynn Canal.

EFFECTS OF ALTERNATIVE B

The primary visual impact associated with Alternative B is the introduction of form, line, color, and texture contrasts from a tailings dam constructed across Sherman Creek. (*See Figure 4-7, Simulation of Sherman Creek Tailings Dam*). The 2,400 foot long, 270 foot high dam would stretch across the lower portion of the U shaped Sherman Creek drainage, introducing a large scale horizontal element.

Coarse rock texture and gray/tan colors associated with the rock on the dam face would contrast with the surrounding areas of dark green forest. The proposed dam construction technique would permit reclamation of the face of the starter dam, and each subsequent raise, immediately after each construction phase is completed. Establishment of grass cover on the dam face would reduce the visual contrasts between the dam and surrounding vegetation.

The starter dam would be completed during the first 2 years of construction, and subsequent raises would occur annually until year five. Three more dam raises would be constructed at 3 to 4 year intervals thereafter.

During construction there may be a substantial, though temporary, impact if the entire impoundment area is cleared before the dam reaches its final height. The dam would also screen the entire process area from view once the final lift is completed. Haul and access

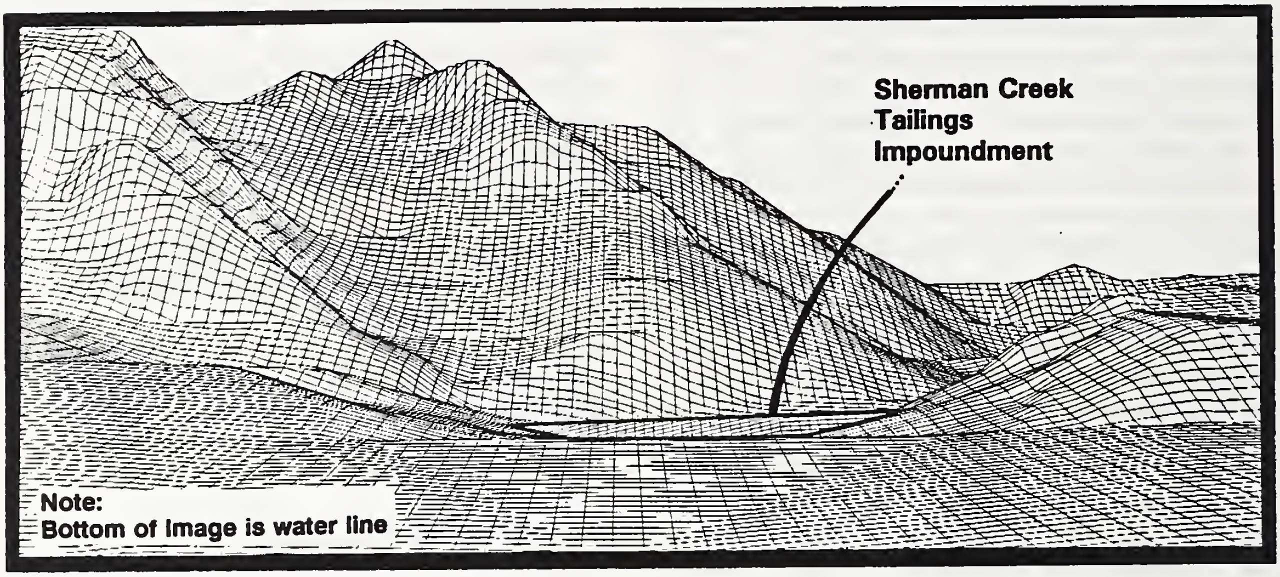

Figure 4-7, Simulation of Sherman Creek Tailings Dam

roads would be mostly screened by trees from view from Lynn Canal.

Most of Alternative B occurs in a Variety Class B, Sensitivity Level 1 area with Visual Quality Objective of Partial Retention. It would be difficult to meet the Visual Quality Objective during operation, but reclamation and revegetation following operation would make it possible to meet the Visual Quality Objective.

EFFECTS OF ALTERNATIVE C

The visual impacts associated with this alternative for the dam and mill site are the same as Alternative B, with two additions, a marine terminal in Slate Creek Cove and an 8.5 mile access road from the terminal to the mine site.

The marine terminal in Slate Creek Cove, while relatively small in scale in terms of structures, would create contrast with the existing landscape by clearing 3 acres for marine terminal components. The cleared areas would accommodate a generator, fuel storage/laydown, heliport, and explosives storage. The structures would be small in scale. A docking facility would introduce contrast by inserting a line into the uniform sweep of the shoreline.

The majority of the access road from Slate Creek Cove would be located on the Lynn Canal side of the peninsula. However, clearing for the road would introduce contrasts in color and texture in the vegetation on both sides of the peninsula. From some viewpoints in Berners Bay, a notch in the trees would be visible where the road would cross the ridge separating the Slate Creek drainage from the Lynn Canal side of the peninsula.

On the Lynn Canal side, the road cut would likely be most visible from the ridge down to the relatively flat, naturally occurring bench which the road would follow to its intersection with the access road from Comet Beach to the mine. Most portions of the road along the bench would be screened from view by trees except where the road would cross open muskeg areas. The visual impacts would result from altering the horizon created by the forested ridge of the peninsula and from contrasts in line, color, and texture due to clearing for the road and cut and fill areas. Brown hues associated with fresh cut and fill areas would contrast with adjacent vegetated sites. However, these visual impacts would be relatively short-term since efforts to stabilize and revegetate these disturbances would occur immediately after construction.

On the Lynn Canal side, the project components, Including the access road are in the same Visual Management System classification described for Alternative B. The road portion of Alternative C would meet the Visual Quality Objective facing Lynn Canal. In the Berners Bay viewshed, the marine terminal would be located in an area designated as foreground distance zone, Variety Class B, Sensitivity Level 2, and Visual Quality Objective of Partial Retention. As with the marine terminal on Lynn Canal, the Visual Quality Objective likely would not be met during operation, but could be met with reclamation and revegetation.

EFFECTS OF ALTERNATIVE D

The unique visual impacts associated with this alternative would come from construction of a tailings dam across Sweeny Creek and the haul road required from the mine to the tailings impoundment. Additionally, from some viewpoints, the process area at the mine would probably be visible. Visual impacts associated with the haul road would be relatively minor compared to the facilities and impoundment areas. Only minor portions of the haul road would be visible where it crosses the end of the ridge between Sherman and Sweeny creeks.

The Sweeny Creek dam, 1,400 wide at the crest and 370 feet high, would introduce contrasts in form, line, color and texture. (*See Figure 4-8, Simulation of Sweeny Creek Tailings Impoundment*). The narrower, more incised shape of the Sweeney Creek drainage results in a higher dam. The horizontal line of the dam is in contrast to the angular lines of the landscape. Topographic screening reduces the view duration of the tailings dam.

The lower portion of the Sweeney Creek drainage has the same Visual Management System classification as Alternatives B and C. Moving up the drainage, the Variety Class becomes C, and then as the view is obstructed, to Sensitivity Level 3, Variety Class C, with a Maximum Modification Visual Quality Objective. The proposed dam would occur in a Partial Retention Visual Quality Objective area. Due to the oblique view angle and the shorter duration of view, the Visual Quality Objective could be met following operations. The combined impact of the dam haul road and the dam may preclude meeting the Visual Quality Objective during construction and operation.

EFFECTS OF ALTERNATIVE E

The major visual impacts from this alternative would be introduction of form, line, color, and texture contrasts with construction of the dewatered tailings impoundments. (*See Figure 4-9, Dewatered Tailings Simulations*). The two dewatered tailings options, Site A on the north side of Sherman Creek, and Site B, on the south side, share similar visual characteristics, but differ in the relative degree of overall visual impact.

Both disposal options would result in steep-sided, relatively flat topped heaps that would introduce a blocky, abrupt form in a landscape characterized by steep slopes ending in jagged or rounded peaks. These effects could be mitigated on final reclamation by re-contouring the pile top and revegetating the surface. The dewatered tailings would expose to view a large surface area of grayish colored waste rock, which upon revegetation with grasses, would be somewhat softened to a contrasting green color

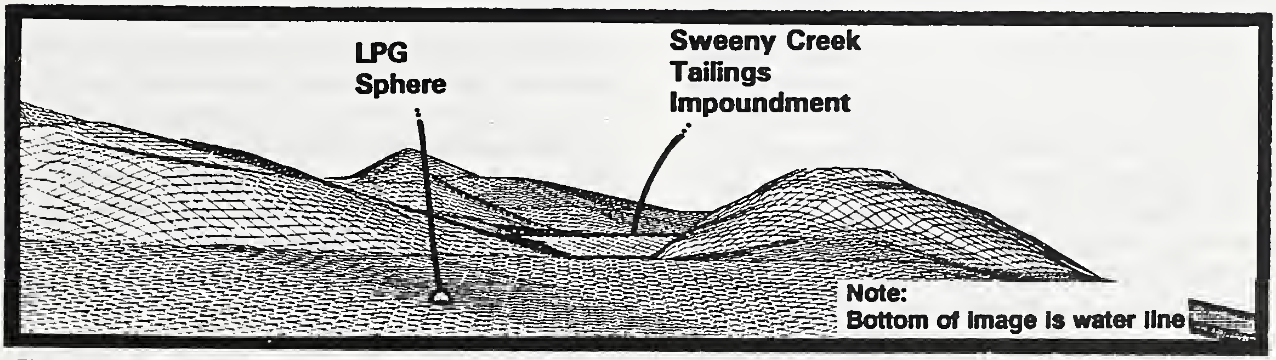

Figure 4-8, Simulation of Sweeny Creek Tailings Impoundment

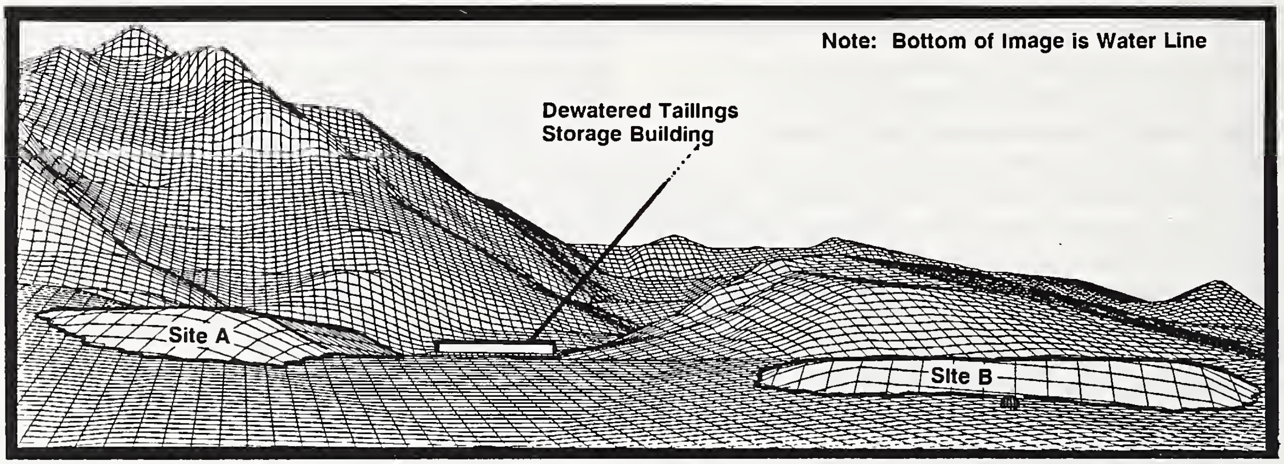

Figure 4-9, Dewatered Tailings Simulations

and texture. Expanses of grasses are not common in the vicinity of the project and would result in contrast in color and texture with the dark green texture of the surrounding forested slopes.

The specific impacts associated with the two sites are due primarily to their proposed locations. Site A is more elevated in the landscape than Site B, however Site B is closer to the critical viewpoints in Lynn Canal and in a more open part of the viewshed. The tailings in Site A would be seen from an angle, whereas at Site B the longest dimension of the heap would parallel the Lynn Canal ship route.

The fill slope of the process area, along with the buildings on it, would be visible behind and to the south of the Site A heap. Compared to the dewatered tailings, the form contrast of the process area would be minor. But, the horizontal line introduced by the fill and the buildings would likely be emphasized by the visual extension of the horizontal line of the top of the dewatered tailings.

Utilizing Site B would bring a major visual impact to the most sensitive part of the viewshed close to Lynn Canal. Though the surface disturbance of the Site B heap is somewhat less, the total project visual disturbance to Sherman Creek drainage is more dispersed under this option.

The Site A disposal option occurs in the same Visual Management System classification as Alternatives B and C. The combined visual impacts of the process area and tailings disposal would preclude meeting the Partial Retention VQO during construction and operation. The Site B disposal option occurs in the same Visual Management System classification as alternatives B and C, but the major visual impact is close to, or just within, the Retention VQO along the shoreline of Lynn Canal. The VQO could not be met for the tailings disposal during operation and construction. Following closure and revegetation it is expected that the visual quality objective would be met.

EFFECTS OF ALTERNATIVE F

Alternative F would have the same effects as Alternative B.

CUMULATIVE EFFECTS

Cumulative visual effects are difficult to assess. Since visual impacts are site specific, the cumulative effects of several mining operations would only be perceived by persons who travel past a number of the mines in southeast Alaska. The potential for cumulative visual effects to Berners Bay exists if Alternative C is developed and the Jualin Project becomes operational. There is no other mining operation in the same viewshed of the proposed Kensington Project.

SUMMARY

The visual Impacts of the alternatives can be compared by examining the unique component of each alternative. In Alternatives B, D, E, and F, the unique component is the proposed tailings disposal. Further, the tailings disposal option creates the largest and most permanent visual Impact in all alternatives. Alternatives B, C, and F are the same except for the 8.5 mile long access road and marine facilities in Alternative C. All alternatives occur substantially in the Visual Management System classification of Variety Class B, Sensitivity Level 1 and Partial Retention Visual Quality Objective.

In comparing Alternatives B and C, the access road in Alternative C is an additional visual impact. An advantage of Alternative B over C is less disturbance to soil and vegetation and, consequently, less visual impact. Alternative C impacts two major viewsheds, Lynn Canal and Berners Bay. The Berners Bay terminal is the only project component likely to be seen in the foreground distance zone. The Visual Quality Objective likely could be met following operations but not during construction and operation.

The tailings dam in Sweeny Creek (Alternative D) presents a smaller appearing dam face visible for a shorter duration from critical viewpoints in Lynn Canal. The tradeoff is a 50 foot wide haul road from the process area to the Sweeny Creek disposal area and an unobstructed view of the process area from another viewpoint. The partial retention Visual Quality Objective would be attainable following construction and operation and possibly during operation.

The comparison between Alternatives B and D shows that an advantage of the Sweeny Creek dam (Alternative D) is the shorter duration view a person in the Alaska Marine Highway and tour ship route of Lynn Canal would have of the tailings dam. The temporary impacts may be slightly greater due to the large haul road needed and to the visibility of the process area. An advantage of Alternative B is that all impacts are confined to the Sherman Creek drainage. During operation, the process area would be screened from the viewer once the dam reached its final height. The disadvantage of this site is that viewers in Lynn Canal have a wide angle view of the process buildings for approximately 10 minutes. While the Visual Quality Objective likely could be met following operations, it may be attainable sooner with Alternative D.

Alternative E, especially Site B, presents the greatest visual impact primarily due to the introduction of a large scale, uncommon form.

Persons viewing the alternatives from the air would have a different perception than the simulations show. To an air traveler, the alternative with the smallest surface disturbance, and greatest revegetation potential, is likely to cause the least visual impact.

SOCIOECONOMICS

This section describes the potential effects of the project alternatives on socioeconomic factors.

EMPLOYMENT AND PAYROLL EFFECTS

Economists sometimes use an employment multiplier to help express the effect that economic activity has on a community. The employment multiplier is an estimate of the number of new jobs in service or other sectors that results from each basic industry job created. For the CBJ the employment multiplier is estimated at 1.74. This means that for every 100 new basic industry jobs in the community, 74 support and service sector jobs are created.

The actual size of the multiplier varies depending upon the availability of the goods and services required by the industry to operate and the portion of the total payroll that is actually spent in the area. The geographic location of Juneau and lack of manufacturing industries in the area results in a reliance on imports of goods and services from other regions. The more dollars that must be spent on goods and services obtained outside the local economy, the smaller the size of the multiplier and the associated benefits to spin-off industries. Consequently, the employment multiplier for Juneau is smaller than that of metropolitan areas with greater industrial capacity.

POPULATION RELATED EFFECTS

The close relationship between changes in employment and changes in population allows projections of population growth to be derived from examination of employment trends. State government employment has dominated Juneau's economy since statehood and today more than half the local economy is either directly or indirectly dependent on State government. Two factors work to influence the level of State government employment and indirectly, the economic health of Juneau. The Alaska State population determines the demand for State government services and State government income determines the degree to which these services can be provided. Approximately 85 percent of State government income is currently derived from oil tax revenue (The McDowell Group, 1990e). Therefore, the accuracy of any forecast of future population trends for Juneau is primarily dependent upon the future price and production level of crude oil and the response of State government hiring to changes in State revenue. Higher crude oil prices and subsequent increases in State revenues would typically result in increased State government employment but the governor has been working to trim State expenditures. As a result, any increases in State government employment are apt to be modest (Northern Economics, 1990). Because of the great amount of uncertainty surrounding these key variables, population projections vary considerably. Two alternative scenarios are considered in this analysis.

Scenario A (Northern Economics, 1991) uses the U.S. Bureau of the Census 1990 population estimate of 26,696 as a starting point and is driven by the Alaska Department of Revenue's (DOR) Fall 1991 high-level oil price projections. Under this scenario, population reaches a peak of 28,731 in 1999 and then slowly drops to 28,360 in 2008. This is 1,664 more people than the 1990 population.

Scenario B (BERGER/ABAM) was developed for the CBJ socioeconomic impact assessment of the Kensington Mine and uses the CBJ 1990 population estimate of 28,881 as a starting point. The projection is driven by the higher mid-level oil price projections made by DOR in Fall 1990. This forecast incorporates the combination of natural increases (births less deaths) and net migration into the relationship between employment changes and population growth. Tourism is expected to grow at a rate of 2 percent per year and a slight increase in fishing and fish processing employment is anticipated. Under this scenario population is expected to grow rapidly through 1992 and reach a peak of 32,442 in 1998. The trend is then reversed and population steadily declines throughout the remaining forecast period. *Figure 4-10, Effects of Kensington Mine on Juneau Population Growth* illustrates the change in population over time for both scenarios relative to their respective estimates of the current Juneau population level.

EFFECTS OF THE NO ACTION ALTERNATIVE

Under the No Action Alternative, the Kensington site would remain under the administration of the Forest Service. It is assumed that exploration work would cease because of the lost opportunity for full development of the mineral potential.

City and Borough of Juneau

The Kensington Venture employed approximately 40 to 50 people in exploration operations at the proposed mine site in 1990. These jobs would be lost as a result of abandoning exploration efforts. The associated loss in payroll would be $4 to $5 million. Under both population forecasts described above, employment and income are projected to decline moderately in the long run due to reductions in oil revenues and the associated cutbacks in State programs. Selection of the No Action Alternative would forego an opportunity for expansion of the mining industry and the offsetting employment and income that would have accrued to the City and Borough of Juneau.

Local purchase of supplies and services related to the exploration effort would be discontinued. As a result of the multiplier effect, the total reduction in employment for Juneau would be 70 to 90 jobs.

Because exploration work would cease under the No Action Alternative, some proportion of the workers, along with their families, would

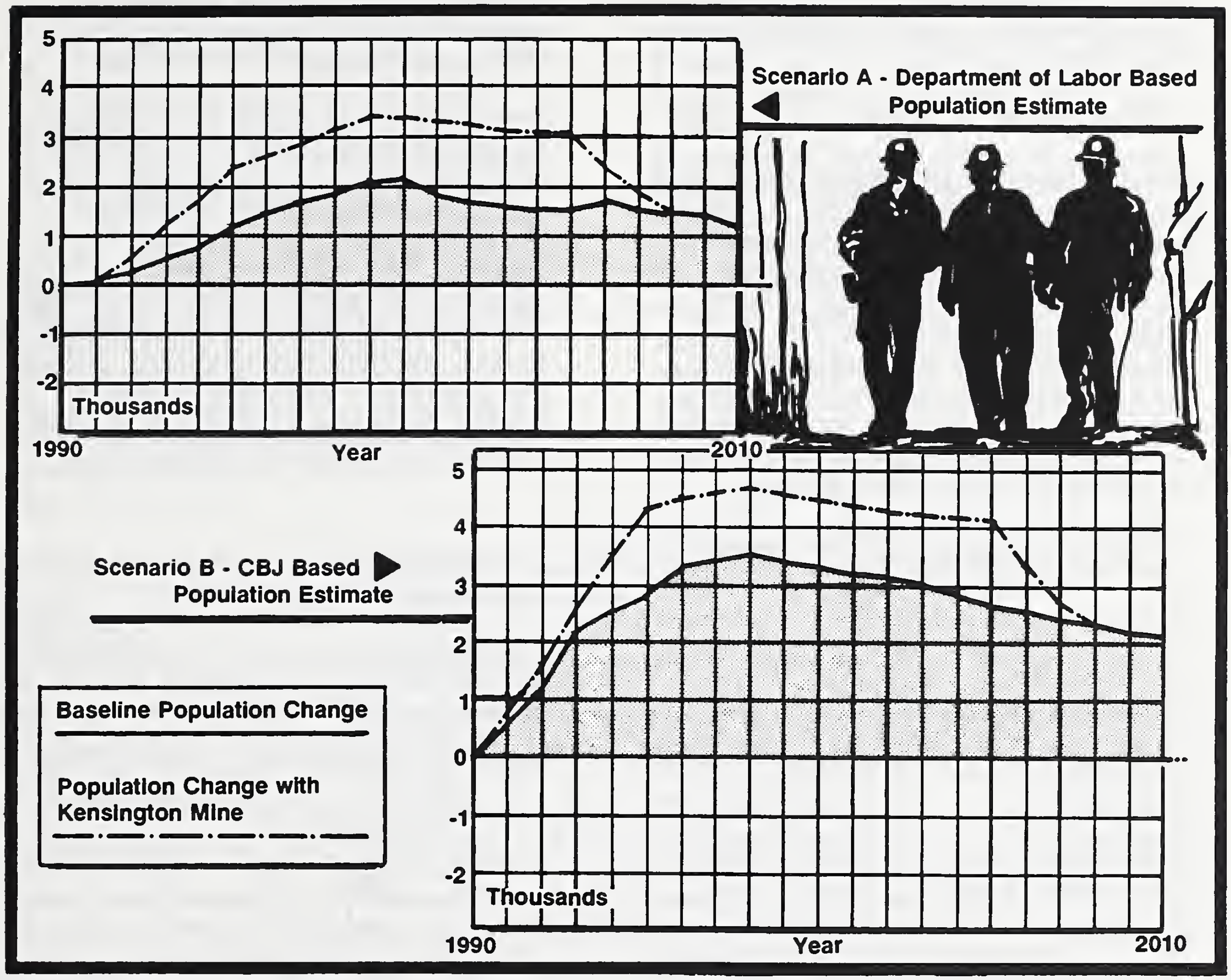

Figure 4-10, Effects of Kensington Mine on Juneau Population Growth

leave the Juneau area in search of other employment opportunities. Census data indicates a 1990 average family size of 2.7 persons for the Juneau area. Applying this figure to the above projected loss in total employment provides an estimated reduction in population of 189 to 243 persons under the No Action Alternative. The actual number of people leaving the area would depend on individual family size and the ability of the newly unemployed to find other work in the community.

Although population projections under the No Action Alternative are lower than those of the action alternatives, total population is not expected to drop below the current level for the projected mine life. Consequently, the shortage of available housing in Juneau would remain a problem. Planned expansion of facilities that are near capacity would still be required.

City of Haines, Borough of Haines, and City of Skagway

Current exploration activities for the Kensington Project do not affect Haines or the City of Skagway, thus, ending those activities would not affect these communities.

EFFECTS COMMON TO ALL ACTION ALTERNATIVES

There is little variation in socioeconomic effects among action alternatives because the primary differences are related to the physical design of

mine operations. The effects of all action alternatives would be similar to those discussed in the following sections.

City and Borough of Juneau

Direct Employment and Payroll Effects. All of the action alternatives would result in increased employment and income to the Juneau area. The proposed development is scheduled to take place in three phases over a period of 16 years. Construction of surface and underground facilities is planned for the first 2 years followed by an operational phase of 12 years and a 2 year period of decommissioning. During the final phase, employment would be scaled back as mining ceases and final reclamation begins. Annual estimates of employment and payroll are listed in *Table 4-26, Kensington Mine Employment and Payroll.*

Each phase of the proposal would involve a different workforce component. The workforce during the period of construction would be composed of many different categories of occupations including: heavy equipment operators, truck drivers, and other earth-moving trades for road and tailings dam construction; mine workers for development of underground facilities; and carpenters, electricians, plumbers and pipefitters for construction of surface facilities. In addition, other workers would be employed to complete specialized tasks.

Table 4-26, Kensington Mine Employment and Payroll

	Phases of Proposed Mine Development									
	Construction		Operations						Reclamation	
	1	2	3	4	5	6	7	8-14	15	16
Total Payroll ($MM)	6.9	10.8	10.7	12.9	12.9	12.9	12.9	12.9	5.4	1.8
Employment										
Construction	170	185	0	0	0	0	0	0	0	0
Pre-Production Mining	186	266	0	0	0	0	0	0	0	0
Operations	0	0	300	361	361	361	361	361	150	50
Total Direct Employment	356	451	300	361	361	361	361	361	150	50
Less Non-Juneau Workforce										
Haines Residents	18	23	15	18	18	18	18	18	8	3
Skagway Resident	7	9	6	7	7	7	7	7	3	0
Construction Camp Workforce	192	197	0	0	0	0	0	0	0	0
Net Juneau-Based Direct Employment	139	222	279	336	336	336	336	336	140	47
Support Sector Employment	88	129	195	236	241	250	248	248	114	43
Less Number of Spouses Employed	35	63	110	144	160	172	181	188	78	26
Net Support Sector Employment	53	66	85	93	81	78	67	60	36	17
[1]Total New Job Opportunities	444	580	495	597	602	611	609	609	264	93

[1]Direct Employment + Support Sector Employment.

The operational phase of the mine would requlre a more speclallzed workforce, Including crews experienced in underground mining and mil operations, along with onsite general management personnel. Although mining currently represents a relatively small share of the total employment in Juneau, the average wage of $4,100 per month (Alaska Department of Labor, 1991) is considerably higher than the state's average monthly wage of $2,470. This is reflected In the high payroll associated with the operational phase of the project and has important implications for a wide variety of industries In the Juneau area. Administrative, service and maintenance personnel would also be employed throughout the life of the Kensington Project.

Indirect Employment and Payroll Effects. Outlays for construction of the mine are estimated at $150 million and annual non-personnel operating costs are budgeted at $30 million. The McDowell Group (1990b) estimates that only five percent of the materials and sub-contracted labor included in these figures would come from local sources. This translates into $7.5 million of purchases over the 2 year construction phase followed by annual expenditures of $1.5 million during operation. These figures are based on the fact that there are limited mine-related industries in Juneau at present. In the event that mining becomes more prominent in the local economy it is likely that industries specializing in mine-related needs would follow. Although a large portion of the construction and operating budget would not be captured by the local economy, the earnings of mine workers would contribute to the sales of a wide variety of local businesses.

When the multiplier concept is introduced, annual employment estimates reach a peak of 609 jobs during operations, 361 of which are directly provided by the mine and 248 indirectly supported by its presence (Northern Economics, 1990). Over time, employment gains would be realized in trade and service industries and finance, insurance, and real estate businesses as the effect of the mining operations stimulates the economy. Additional local government jobs would also be required to respond to a higher level of demand for public services.

Population Effects. Employment opportunities at the Kensington Project would alter the population projections described above. The September 1991 unemployment rate for the Juneau Borough was 5.8 percent (Alaska Department of Labor, 1991) with a total of 967 persons actively seeking work. Given that the local labor supply is limited, even if a number of area residents were to be employed at the mine, other people would move into Juneau to fill the vacancies created. This analysis assumes that every job directly or indirectly resulting from mine development would require the addition of a non-resident worker to the local workforce.

Factors influencing the relationship between employment opportunities and population change include decisions made by individuals to relocate or commute to Juneau and the family size of in-migrating workers. The Kensington Venture would build a 250 person camp to accommodate construction workers at the mine. The availability of on-site lodging would substantially reduce the number of construction workers and dependents relocating to the community during the first 2 years of the development. Only 5 percent of the surface construction workforce is estimated to relocate to Juneau. Underground mine construction workers are prime candidates for long-term employment during the operational phase, and it is assumed that 70 to 80 percent would choose to reside in Juneau. All Kensington Venture management staff are expected to reside in the community. These are the only groups with workers expected to be employed long enough during construction to justify moving their families and living in the community. All workers employed during the operational phase of the project are expected to reside in the local community.

Based on data collected on the Greens Creek Mine (Heatherly, 1990), the family size for mine-related employees is estimated at 3.89. The family size for workers moving to the community in response to indirect employment opportunities is 2.7 based on the 1990 census estimate for Juneau. In addition to workers and dependents, a number of unemployed job seekers would likely be attracted to the area. Also, some workers hired during the construction phase would be retained when mine operations begin. In total, the Kensington

Project would increase Juneau's population by approximately 1,250 people when the mine is in full production. Annual estimates of mine-related population are listed in *Table 4-27, Population Effects of the Action Alternatives*.

Under scenario A (*Figure 4-10, Effects of the Kensington Mine on Juneau Population Growth*), mine development triples the rate of population growth during the initial years of the project. By the year 1995, an additional 2,350 people are expected to reside in the community. This is followed by moderate population growth through the year 1999, at which point a total population increase of 3,000 persons is maintained. When shutdown of the mine begins In 2006, some 700 people are projected to leave the community. Another 350 people are expected to emigrate during the final year of decommissioning. This amounts to Juneau losing 2 to 3 percent of its population over a 2 to 3 year period. Upon closure of the mine, approximately 1,350 additional people are expected to reside in Juneau in comparison to current conditions.

Under scenario B (*Figure 4-10, Effects of the Kensington Mine on Juneau Population Growth*), mine development exacerbates the high rate of growth projected to occur during the initial years of the project's development. By the year 1995, an additional 4,234 people are expected to reside in the community. This is approximately twice the rate of growth portrayed under scenario A with nearly two-thirds of the change attributable to the more robust baseline forecast. Population growth peaks in 1999, reaching a level approximately 4,700 persons above current estimates. After this point, a steady decline in population is predicted, which is accelerated by the shutdown of the mine in 2006. At this point some 542 persons are projected to leave the community within the first year, followed by an additional emigration of 361 people after the final year of decommissioning. This amounts to Juneau losing 3 to 4 percent of its population over a 2 to 3 year period. After the mine's closure, Juneau's population is projected to have increased by 2,036 relative to current estimates.

The scenarios described above quantify a plausible range of effects from implementation of the action alternatives. The actual impacts from developing the Kensington Project would probably occur at a point somewhere in between the high and low scenarios presented in this analysis. Forecasts become more subject to uncertainty and, therefore, less reliable the farther into the future they extend.

Both scenarios produce similar conclusions for the initial years of the proposed development; an additional 1,200 people will move into the area and increase pressure on the housing market and community infrastructure. The impact of mine-associated population will depend upon the difference between the expected rate of population growth, the actual population increase, and the existing and planned capacity of facilities and services in the Juneau area. The sections to follow examine the ability of the community to absorb the initial population-related impacts of the action alternatives.

Housing Effects. The CBJ estimate (October 1991) of the total number of dwelling units in Juneau area is as follows:

Single-Family Dwelling Units	4,160
Condominium Units	842
Units in Duplexes	1,393
Units in Zero Lot Line Structures	712
Units in Multi-Family Structures	2,273
Mobile Homes	1,120
Total Dwelling Units	10,500

These figures reflect the supply of standard year-round housing units and not inclusive of an estimated 63 miscellaneous housing units such as RV's, live aboard boats and hotel rooms.

Vacancy rates provide an indication of the potential for housing development and an estimate of the number of housing units available at a particular point in time. The most recent vacancy rates for Juneau area (September, 1991) are as follows: single family dwellings (including condos, duplexes, and zero lot lines) 1.5 percent, multi-family dwellings 0.8 percent (essentially zero), and mobile homes 1.4 percent. These percentages indicate that are presently 147 vacant housing units available for new residents. The vacancy rate for all housing has declined from a high of 10 percent in 1986 to the current rate of 1.4 percent.

Table 4-27, Population Effects of the Action Alternatives

	Phases of Proposed Mine Development									
	Construction		Operations						Reclamation	
	1	2	3	4	5	6	7	8-14	15	16
Mine Employees and Families	339	607	843	1,034	1,054	1,073	1,093	1,112	462	154
Support Sector Employees and Families	105	123	151	164	142	136	116	103	61	29
Unemployed Workers and Families	40	51	38	45	44	43	42	42	18	7
Construction Workers in Camp	192	197	0	0	0	0	0	0	0	0
Total Mine-Related Population	676	978	1,032	1,243	1,240	1,252	1,251	1,257	541	190
Total Increase to Juneau Population	484	781	1,032	1,243	1,240	1,252	1,251	1,257	541	190

The extremely low vacancy rate is indicative of a very tight housing market. Consequently, all of the housing demand generated by development of the Kensington Project is assumed to translate into the need for additional housing units. *Table 4-28, Unit Demand for Housing* lists the estimated requirement for new housing units on an annual basis by housing type. A total of 411 housing units would need to be made available over a four-year period to accommodate the expected influx of population. One hundred and seventy five of these would be needed within the first year. This demand would that exceed the total supply of vacant housing units by 19 percent. There would be immediate pressure on the community to address a significant shortage in housing availability. Housing needs for those workers indirectly associated with the development of the mine are included in these figures.

Table 4-28, Unit Demand for Housing

Year	1	2	3	4
Single Family	80	11	34	60
Other Owner Occupied	27	27	18	18
Mobile Home	4	4	0	0
Multi-Family	64	51	13	0
Total New housing Units	175	93	65	78
Cumulative Housing Demand	175	268	333	411

A study done by the McDowell Group (1990b) concludes that for reasons described below, the demand for rental units within the mine-related population would be proportionately greater than that of the current population. For purposes of this analysis, 40 percent of the demand for housing (107 units) during the first two years of the project is expected to be for rental units.

As a consequence of the low availability of housing accommodations in Juneau, the increase in demand will be reflected in higher prices in the short term. Both rental rates and purchase prices can be expected to increase along with property assessments. While some homeowners would welcome the opportunity to sell property purchased during the high market conditions of the mid 1980's, others would be negatively impacted by the associated increase in property tax payments.

Intuitively, one would believe that the lack of housing and high purchase prices would lead to an immediate surge in construction. Investments, however, are based largely on expectations. Both Juneau, and Alaska in general, have demonstrated erratic growth trends creating an atmosphere of uncertainty for lending institutions. As a result, lenders in the community are requiring a 25 percent down payment to secure financing for new contract construction (McDowell, 1991). The incentives for speculative construction are limited, as loans are granted only to developers whose personal and business financial statements indicate an ability to carry their projects until a buyer is found. An additional factor to consider is the fact that builders face strict regulations which add to the cost of subdivision land and the price of new homes.

There are several factors which negatively influence the ability of Juneau residents to purchase homes. Many financial institutions in Juneau had numerous foreclosed properties during 1987 and 1988. A total of 178 foreclosures on residential properties occurred during this time period for an estimated loss of $3.5 million to lending institutions (McDowell, 1991). As a result, the availability of private mortgage insurance is limited, resulting in a down payment requirement of 20 percent to secure financing. The considerable amount of cash needed to purchase a home limits the number of new resident who will be able to afford one. Also, mortgage contracts for periods in excess of the operational life of the mine, may introduce some question as to the ability or incentive of workers to successfully complete a financial agreement, especially in the event of an unexpected shutdown.

In summary, the projected demand for housing stock will exceed the capacity of the existing vacant housing supply and the construction of new accommodations will be dependant on the perception of the financial community as to the stability of the investment climate and Juneau's future economic growth, both of which are surrounded by a great deal of uncertainty. Without incentives to reduce the risk of investment, additions to the existing housing stock will occur as a result of careful evaluation and with guarded optimism.

School Enrollment. The action alternatives would result in additional students for the Juneau School District. Current enrollment distribution is approximately 51 percent kindergarten through grades 5, 23 percent middle school (grades 6 through 8), and 26 percent high school (grades 9 through 12). If mine-related enrollment follows this pattern, at full production in Year 6 of the Kensington Project, new students would include 130 in grades kindergarten through 5, 60 middle schoolers, and 60 to 70 high school students. The upper range of 260 students represents a 5 percent increase over the present enrollment of 5,228 students.

These students would be added to the school system over a 6 year period beginning in 1993. The effect of the additional students on the public school system would be to prolong the disproportionate share of students in elementary grades and add to the need for increased capacity already recognized by the school district. Because of the need to accommodate existing students the Juneau School District has immediate plans to build a new middle school. Additional space requirements would be met by adding modular classrooms at Auke Bay, by utilizing space at Capital School, by renovating Gastineau School, and by realigning Marie Drake to allow use by elementary students (as well as high school students in the future) (The McDowell Group, 1990e). The School District is also considering construction of a new elementary school. School capacity is an existing problem and would continue to be regardless of the outcome of the Kensington proposal. The mine-related enrollment would partially fill the additional capacity created to meet the needs of the current population.

Health and Social Services. The Kensington Venture would provide emergency medical equipment at the mine and intends to contract with a local group to provide ambulance service to the site. The fire department provided EMS/MEDIVAC services during the exploration program. Additional staffing may be required if the department would continue to provide these services throughout the life of the mine.

Bartlett Memorial Hospital would experience an increase in admissions due to accidents and illnesses occurring in the mine-related population. During 1987 through 1989, the metal mining industry incurred injuries and illnesses at 2.2 times the State's industrial average (derived from information provided by Wilson, 1990). Hospital occupancy resulting from the influx of mine employees could be expected to increase at a higher rate than that of population growth. The hospital occupancy rate was 47.5 percent in 1988, and 49.5 percent in 1989. Capacity limitations for inpatient services would not be realized until occupancy reaches 70 to 80 percent. An estimated 7 percent increase in occupancy rates as a result of the mine development would leave the hospital well below this limit.

Substance abuse services in Juneau are provided by the City and Borough of Juneau, the U.S. Indian Health Service through contract with the southeast Alaska Regional Health Corporation, and Lakeside Recovery Corporation, a private organization. The CBJ's Chemical Dependency Division is the only entity that would be expected to incur additional net costs because it provides charitable allowances for low-income patients. The Lakeside Recovery Corporation accepts patients who can pay charges and the U.S. Indian Health Service covers Alaskan Natives regardless of residency.

"The permanent mining population will only require treatment at an above average rate if the mine is disproportionately composed of young males. If the age and sex ratios of the mining population are the same as current Juneau ratios, then there will be no disproportionate increase in the demand for chemical dependency services. The support sector population will presumably require treatment at about the average rate in the Juneau population" (McDowell, 1990c). Other factors

for consideration are the Kensington Venture's drug testing program for all employees and the fact that most of the construction crew would live at the remote camp.

The Kensington Venture's health insurance plan would cover substance abuse and would transfer some of the treatment burden away from the CBJ to other providers. However, the insurance plan's 90-day exclusion for pre-existing conditions and the high employment turn-over rate for mine employees could lessen the effectiveness of this program (The McDowell Group, 1990b). Construction contracts have not been signed so the insurance coverage available to construction workers is not known.

Mental health services are provided by the Juneau Alliance for the mentally ill, the CBJ's Juneau Mental Health Clinic, and private sector providers. Limited mental health services are available to Alaska Natives through the southeast Alaska Regional Health Corporation. The Mental Health Clinic had a long waiting list in 1988, but this list could be reduced if the clinic were fully staffed.

Juneau currently has a shortage of primary care physicians. Population increases would compound the shortage (Walsh, 1991).

Public Safety. No noticeable increase in crime rates occurred in Juneau as a consequence of the construction of the Greens Creek mine. For purposes of this study, the estimated five percent population increase from development of the Kensington Project can be expected to require an increase in Juneau police services. Police protection for the mine site itself would lie in the jurisdiction of the Alaska State Troopers.

The Kensington related population increase would not create a need for additional fire department personnel or equipment. Although more homes would be occupied and constructed, the fire department has sufficient staff and equipment to meet the potential four percent increase in demand.

According to the Fire Chief (Fanning, 1990), development in certain areas of North Douglas and the Mendenhall Valley may be beyond the time response zones for existing fire insurance ratings, which would result in higher fire insurance costs for persons building in those area. Additional stations would be an asset in reducing premiums but fire protection would not be compromised without them.

Public Utilities. The Kensington Project would not draw upon the water utilities of the CBJ since an onsite water supply would be established. Population growth associated with development of the mine would result in additional residential and commercial demand for water from the CBJ's system. According to the McDowell Group (1990b), the downtown and valley areas have water capacity that is far in excess of demand and sufficient to handle any Kensington related service demand.

The Kensington Venture would install an onsite wastewater treatment facility for its workforce and operations which would be separate from any facilities within the CBJ.

New residential development is expected to occur primarily in the Mendenhall Valley and North Douglas where the most land is available. The Mendenhall Valley treatment plant is operating at about 50 percent of capacity and can handle increased residential loads. Residential areas in the Valley and North Douglas that are not connected to treatment plants would treat wastewater with onsite septic systems.

Population growth would result in some additional commercial development, primarily in the downtown area. The Juneau-Douglas treatment plant experiences overload situations during extremely rainy weather when stormwater runoff enters the sewer system. According to the McDowell Group (1990b), the Department of Public Works has a multi-year program to place storm runoff separators in the area. This would substantially increase the capacity of the plant and permit it to handle additional development.

The Kensington Venture plans to construct an onsite incinerator at the mine to dispose of burnable materials. Non-burnable materials and ashes from the burnable materials would be hauled from the site to Juneau for disposal. The solid waste disposal site operated by the Channel Corporation has a 20 to 30 year

capacity. The Channel Corporation and the CBJ are considering recycling programs and expansion of the incineration system presently employed. Kensington related population growth would reduce the expected life of the existing landfill site.

Electric power for mine construction and operation would be provided by an onsite facility and mining operations would not directly impact power consumption or electric rates. Current electrical demand is about 270 million kilowatts, and with the Crater Lake addition, Juneau's total capacity would be about 340 million kilowatts. The population growth attributable to the Kensington Project would increase total demand but would still leave a large excess available for further growth.

Effects on CBJ Revenues and Expenditures. The proposed development increases both revenues and expenditures for the CBJ. As discussed below, the low property tax mil rate applied by the CBJ in roadless areas along with the decline in the State's share of school district funding results in fiscal deficits for the CBJ throughout the construction and operating years. Funding deficits would be greatest during the first few years of the proposed development when the full range of community services would be demanded by the mine-related population before the assessed value of the mine had reached its highest point. An annual summary of the fiscal impacts associated from the proposed development of the Kensington Project is presented in *Table 4-29, Effects of Kensington Mine on CBJ Revenues and Expenditures*.

Property tax revenues would increase due to the value of new residential and commercial construction as well as the value of the mine and its improvements. Property taxes were estimated by assuming a constant rate of 5.4 mils throughout the life of the mine for its constructed cost and on-going capital expenditures during operations. This is the lowest property tax rate levied by the CBJ and corresponds to that applied to off-road property. The CBJ currently does not have a specific policy with regard to mine property taxation and tax revenues could vary considerably from those calculated for this analysis in the event that one is developed (McDowell, 1990b). A 13.4 mil rate was assumed for the new residential and commercial construction. Property is assumed to be assessed at its market value or construction cost in the year it is built, but revenues are not received until the following year. This does not include property tax revenues generated from the rise in property values associated with increased demand.

Sales tax revenues would accrue to the CBJ from supplies purchased locally during the construction and operation of the mine. As previously mentioned, only 5 percent of the annual non-personnel operating budget is estimated to be spent locally. A tax rate of 4 percent was applied to this amount to calculate the total CBJ revenue contribution.

The sales tax revenue collected from the personal expenditures of individuals was based on an annual amount of $450 per person, (excluding construction workers at the mine) as calculated by the McDowell Group (1990b). Currently, half of sales tax revenues are committed to roads and other major capital improvements. These dedicated funds were not included in this analysis as they are not available to offset general fund expenditures. Enterprise funds from sewer and water utilities were also excluded from the calculations.

Revenues from State sources such as municipal assistance, health and social service grants and SSR/SOADA chemical dependency grants were based on the 1988 to 1990 fiscal year per capita averages. Revenue sharing fluctuates in accordance with a State formula based on population and property value assessments. These funds were assumed to remain constant on a per capita basis throughout the study period.

The school district would experience a net loss in revenue due to the State and CBJ funding methods. As part of an agreement between the CBJ and the school district, a contribution of $2,240 per student is made from the general fund for school operations. State foundation funding for the school district is determined by the property tax base and the education mil rate. The formula causes State funding to drop when property values increase. As the Kensington project would increase property valuation in the CBJ, the total level of State

Table 4-29, Effects of Kensington Mine on CBJ Revenues and Expenditures ($x1,000)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Revenues																
Property & Sales Taxes	389	1,193	1,815	2,059	2,071	2,014	1,949	1,893	1,825	1,749	1,676	1,595	1,514	1,432	878	552
State Sources	198	286	302	363	362	366	366	368	368	368	368	368	368	368	158	55
Federal Sources	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal	$ 587	$1,479	$2,117	$2,422	$2,433	$2,380	$2,315	$2,261	$2,193	$2,117	$2,044	$1,963	$1,882	$1,800	$1,036	$ 607
School Revenues	110	0	387	720	815	931	956	997	1,061	1,123	1,191	1,260	1,329	1,399	541	117
Total Revenues	$ 697	$1,479	$2,504	$3,142	$3,248	$3,311	$3,271	$3,258	$3,254	$3,240	$3,235	$3,223	$3,211	$3,199	$1,577	$ 724
Expenditures																
General Fund	981	1,456	1671	2,027	2,073	2,073	2,063	2,064	2,064	2,064	2,064	2,064	2,064	2,064	889	311
School District	500	832	1,267	1,570	1,611	1,672	1,647	1,630	1,630	1,630	1,630	1,630	1,630	1,630	702	246
Total Expenditure	$1,481	$2,288	$2,938	$3,597	$3,648	$3,745	$3,710	$3,694	$3,694	$3,694	$3,694	$3,694	$3,694	$3,694	$1,591	$ 557
Community Net Gain (Loss)	(784)	(809)	(434)	(455)	(400)	(434)	(439)	(436)	(440)	(454)	(459)	(471)	(483)	(495)	(14)	167
With New Elem. School	(784)	(809)	(434)	(455)	(400)	(1180)	(1160)	(1155)	(1170)	(1211)	(1225)	(1244)	(1256)	(1262)	(449)	(21)

Note: Does not include revenues from enterprise funds (e.g., sewer and water utilities) and related sources.

educational funding would drop. The fixed contribution from the general fund would not be enough to offset the cost of higher enrollment given the current funding methods. The School District may construct a new elementary school if the Kensington Project proceeds. The proportion of the cost of a new school attributable to the Kensington Project is shown in *Table 4-30, School Enrollment Changes with Kensington and AJ Mines.*

development. Additional discussions with departments and agencies identified capital projects that would enhance or improve services. However, the projected decline in State government revenues has resulted in a policy-level decision to restrict further capital projects (Hansen, 1990). A recent CBJ document states that the community policy would no longer allow for construction of additional capital facilities unless non-general

Table 4-30, School Enrollment Changes with Kensington and AJ Mines

	Year					
	1	2	3	4	5	6
Baseline Student Population	5,260	5,326	5,395	5,463	5,518	5,557
Projects Related Students	174	347	409	611	617	649
Total Student Population	5,433	5,674	5,805	6,074	6,135	6,206
Baseline School Enrollment						
Elementary	2,682	2,716	2,752	2,786	2,814	2,834
Middle School	1,210	1,225	1,241	1,256	1,269	1,278
High School	1,367	1,385	1,403	1,420	1,435	1,446
With Projects School Enrollment						
Elementary	2,771	2,894	2,960	3,098	3,129	3,165
Middle School	1,250	1,305	1,335	1,397	1,411	1,427
High School	1,413	1,475	1,509	1,579	1,595	1,614
School Capacity Comparison						
Elementary Capacity	2,520	2,630	2,630	2,630	2,630	2,630
Baseline Surplus (Deficit)	(162)	(86)	(122)	(156)	(184)	(204)
W/Projects Surplus (Deficit)	(251)	(264)	(330)	(468)	(499)	(535)
Middle School Capacity	1,110	1,300	1,300	1,300	1,300	1,300
Baseline Surplus (Deficit)	(100)	75	59	44	31	22
W/Projects Surplus (Deficit)	(140)	(5)	(35)	(97)	(111)	(127)
High School Capacity	1,200	1,600	1,600	1,600	1,600	1,600
Baseline Surplus (Deficit)	(167)	215	197	180	165	155
W/Projects Surplus (Deficit)	(213)	125	91	21	5	(14)

Work by the McDowell Group (1990c) identified several major capital projects currently required in the community but no additional project directly related to the proposed Kensington

fund sources of revenue have been identified (City and Borough of Juneau, 1991). As a result of this situation, the smaller capital projects suggested by department heads have been excluded from this analysis.

A per capita multiplier was used to estimate CBJ costs Incurred as a result of the mine-related influx of population. The assumption was made that the present cost of government service on a per person basis is a reasonable approximation of the cost of providing the same level of service to new residents. The expenditure analysis included departments or categories covered by the general and special revenue funds of the CBJ budget. It did not include the Eaglecrest ski area, water and sewer utilities, harbors, hospitals, and other enterprise funds that are generally self-supporting through user fees.

City of Haines, Borough of Haines and City of Skagway

The Kensington Venture would provide employee transportation from a Juneau location only. Depending on work schedules, employees may have the opportunity to commute from either Haines or Skagway at their own expense. The McDowell Group (1990d) reports that annual expenditures for the commute would total between $1,600 and $3,200. Unemployed individuals would be more likely to disregard the cost and seek employment at the mine. The daily worker commute scheduled under Alternative C would make living outside the Juneau area impractical for most employees. All other action alternatives may employ residents of these communities as a very small percentage of the total mine-related workforce.

Unemployment in Haines hit record levels in the summer of 1991 (Chilkat Valley News, 1991). This could increase the chances that the Kensington Project could have a significant impact on the Haines economy. Persistent high unemployment would result in a pool of workers who may be attracted to employment opportunities at the project. Assuming that a large number of Haines residents become employed at the project, the Haines economy would become less dependent on the timber industry. Spreading the economic base over more industries would help stabilize the economy.

Employment and Payroll Effects. The McDowell Group (1990d) estimated that 15 to 20 Haines residents would be directly employed during the operational phase of the Kensington Project. An additional three to seven jobs could be supported by local expenditures of mine employees. The increase in total employment is substantially less than the annual fluctuation of 400 jobs during the summer season. Based on an estimated annual income of $40,000 for the mine employees and $23,000 for the indirectly supported jobs, a total of $961,000 in additional income would be earned by Haines residents.

A many as seven Kensington employees would be expected to reside in Skagway. This is less than two percent of the 1989 annual average employment in the community. One or two additional jobs could be supported by expenditures of earning from the long-term mining jobs. The increase in total employment is insignificant in comparison to the seasonal employment pattern which results in a summer employment level twice that of winter.

Population Related Effects. Assuming the average family size for Haines residents is similar to that of Juneau, the population increase associated with the upper limit of mine-related employment is about 54 people. This represents a less than 2 percent increase in the present population. The minor growth expected as a result of the proposed development is dwarfed by the seasonal population growth and demand on social services regularly observed in the community.

Total Kensington related population could reach an upper limit of 25 people if all potential employees were new residents. Given the present high unemployment rate in Skagway, it is more likely that Kensington would employ a number of current residents. The minor increase in population would not have discernible impacts on community services.

CUMULATIVE EFFECTS

This section evaluates the impact of both the Kensington Project and the AJ Mine operating in the same general time frame. The proposed AJ Mine would have an initial capital cost of $260.0 million. Construction employment at the AJ Mine would average 120 persons in the first year and increase to 290 in the second year of construction. The production workforce would be about 450 persons. These data and other

Information from the AJ Mine Project Draft Environmental Impact Statement (BLM, 1991) were used to develop this section.

The Kensington and AJ Mines have an estimated economic production life of about 12 to 13 years, respectively. This analysis takes a worst case approach by assuming construction and production for both mines begins simultaneously in the year 1993. Phased start-up would significantly reduce the impacts of both mines in the region.

City and Borough of Juneau

Employment and Payroll Effects. The Kensington Project analysis anticipates that about 35 percent of the workforce would come from Juneau. This is reduced to 25 percent for the cumulative analysis since Juneau may be unable to supply the same workforce requirements for both mines.

Construction payroll for both mines would total about $12 million in the first year of construction and $21 million in the second year. Production payroll would start at $28 million in the first year and increase to $43 million in the fifth year of production. Payrolls would remain at this level until 2005 when reclamation of the Kensington Project begins. Payroll would drop from about $34 million in 2005 to $5 million in 2008.

Population Growth. *Table 4-31, Cumulative Population Effects*, shows the projected baseline population for Juneau under Scenario A; the population associated with both the AJ and Kensington Mines; and the total Juneau population as a result of the cumulative impact of the two mining developments. During full production, the population associated with both mines would account for about 9 percent of Juneau's population. Mining related population would approach its peak in 2000, slightly after Juneau's baseline population peaks. The population impact from both mines would result in Juneau's population reaching a new peak of about 31,712 in 1999.

Table 4-31, Cumulative Population Effects

Year	Scenario A	Kensington Related Population	Related Population	Total Juneau Population
1990	26,696	0	0	26,696
1991	26,696	0	0	26,696
1992	26,858	0	0	26,858
1993	27,098	484	451	28,033
1994	27,444	781	1,104	29,329
1995	27,803	1,032	1,043	29,878
1996	28,154	1,243	1,763	31,160
1997	28,439	1,240	1,687	31,366
1998	28,643	1,252	1,734	31,629
1999	28,731	1,251	1,730	31,712
2000	28,720	1,257	1,732	31,709
2001	28,663	1,257	1,732	31,652
2002	28,544	1,257	1,732	31,533
2003	28,506	1,257	1,732	31,495
2004	28,478	1,257	1,732	31,467
2005	28,476	1,257	1,732	31,465
2006	28,499	1,257	1,732	31,488
2007	28,467	541	1,779	30,787
2008	28,360	190	1,762	30,312
2009	28,222	0	591	28,813
2010	28,052	0	248	28,300

During early years the mines would exacerbate existing situations where facilities or services are inadequate. In later years, the mines would contribute to stabilizing the population as State revenues and State government employment slowly decline.

If both mines closed simultaneous in 2006, Juneau's population could decline by 3,000 persons. This would be a loss of 9 percent of the projected population and would be twice as large as the emigration that occurred in 1985-1988. This would be a severe shock to Juneau's socioeconomic structure. If the closures were not simultaneous, the period of emigration would lengthen and the impacts to Juneau would be moderated.

Housing Market. The numbers of housing units required during the first four years of development for the Kensington and AJ Mines are shown below. A peak of 314 units will be needed in the first year of construction, with fewer units in later years. Units used by construction workers will be available for operations employees in later years. Total housing demand peaks at 973 units in the second year of operations (*See Table 4-32, Housing Demand with Kensington and AJ Mines*).

Table 4-32, Housing Demand with Kensington and AJ Mines

	Year			
	1	2	3	4
Annual Housing Units	314	300	69	291
Cumulative Housing Units	314	614	683	973

This level of housing demand would have a significant impact on housing availability in community which presently has a housing shortage. The housing shortage would intensify, resulting in increased rental costs and sales prices for homes. If present rents increase about 10 percent they will approximate replacement cost until additional housing is constructed.

There is adequate undeveloped and residentially zoned land available to accommodate the new construction.

School Enrollment. The student population associated with both mines would peak at 650 students in 1998 and then level off at about 630 students until production ceased at the Kensington Project. This increase is 12 percent above current enrollment. *Table 4-30, School Enrollment Changes with Kensington and AJ Mines*, provides additional detail on the effect of the student population associated with the Kensington and AJ Mines on school capacity. The high school has sufficient capacity to accommodate the projected student increase resulting from baseline population growth and development of the Kensington and AJ Mines. The middle schools would have adequate capacity to handle the projected increase in students associated with the baseline population growth after completion of the new middle school scheduled to open in the fall of 1994. Development of both mines would result in a student population that exceeds the capacity of the middle schools, even with completion of the new school. Capacity of the elementary schools is inadequate to accommodate the projected baseline student population growth, and the elementary schools will experience additional capacity-related problems with development of both mines. The school district is considering ways to accommodate the projected increase in elementary student population. Items being considered included half days for kindergarten, year-round school, double shifting, and a new elementary school.

Health and Social Services. Inadequate capacity presently exists for mental health and chemical dependency programs, and medical programs administered by the CBJ for free or at minimal cost to persons with low to moderate incomes. Mine workers and their families may ave higher usage rates than the balance of the CBJ population for some of these services but the complete insurance programs provided to employees will cover medical and mental health treatments allowing the mine-related population to use private sector providers. Other persons migrating to the community may not have these same resources and would exacerbate the present situation. Other health services would have adequate capacity to accommodate the

demands generated by development of both mines, although there may be a lag in meeting the initial demand due to the time involved in recruiting and hiring doctors nurses, dentists, counselors, and other professionals.

There is presently an inadequate number of licensed day care providers in the CBJ because: 1) staffing requirements are high, particularly for infants and toddlers; 2) staff turnover in low-wage occupation is high; and 3) home day-care providers can only accommodate a maximum of 6 children. Additional population growth will place additional demands upon the existing services, and shift workers at the mines and will place further demands on existing providers because there are few day care services for persons who work schedules other than the traditional 8:00 a.m. to 5:00 p.m.

Public Safety. Law enforcement, fire protection, and ambulance services would be subject to increased population generated demand of about 9 percent. Law enforcement would require additional staffing, and fire protection services may require additional equipment or facilities dependent upon the pattern of growth In the community. The mining industry has accident rates higher than the average industry in the State so emergency medical and ambulance providers may have a slightly higher demand for their services.

Public Utilities. Municipal water supplies are adequate to handle the mine-related population increases for both mines. The wastewater treatment plants also have capacity to handle additional population generated load, although the Juneau-Douglas plant would remain unable to handle storm water until completion of the CBJ's storm water program.

Development of both mines would reduce the available life of the existing landfill by about 10 years. The population growth for both mines would require additional electrical power but would leave capacity available for further growth. The Kensington Project would provide its own power, and the AJ Mine would purchase power on an interruptible basis.

Effects on CBJ Revenues and Expenditures. The higher mil rate tax district that encompasses the AJ Mine, and royalties and leases which accrue to the CBJ from development of the AJ, result in the cumulative scenario providing a fiscal surplus to the community. *Table 4-33, Kensington and AJ Mines Cumulative Impacts Fiscal Analysis*, shows the effect of development of both mines of the revenues and expenditures of the CBJ and the school district. The AJ Mine is located in a property tax district with a high mil rate, and the CBJ also receives royalties and leasehold rents from the project. These revenues offset the deficits associated with the Kensington Mine and result in a cumulative fiscal surplus to the CBJ. The school district continues to incur deficits because of the funding formulas employed by the State of CBJ.

City of Haines, Borough of Haines and City of Skagway

The AJ Mine is not likely to have any significant effect on either Haines or Skagway, even with development of the Kensington Project. A few residents from these communities could be hired by the Kensington Project if Juneau is near full employment, but the impacts would be comparable to those described previously.

TRANSPORTATION

This section provides a discussion of transportation effects resulting from the project alternatives.

EFFECTS OF THE NO ACTION ALTERNATIVE

The No Action Alternative would cause no change to the existing transportation systems in the Juneau/Haines area. Exploration at the Kensington Project could continue under existing permits so transportation to and from the Kensington Project would remain unchanged. However, projections for Juneau population growth show that traffic service levels along Egan Drive between the airport and Douglas bridge would change from service level B to service level C by 1992 even without mine development.

Table 4-33, Kensington and AJ Mines Cumulative Impacts Fiscal Analysis ($ in millions)

	1	2	3	4	5	6	7	8	9
CBJ Operating Revenues	$1.2	$4.2	$7.3	$9.9	$10.0	$10.8	$11.3	$11.3	$11.0
CBJ Operating Expenditures	1.5	2.8	3.0	4.3	4.3	4.4	4.4	4.4	4.4
Net CBJ Operating Funds	($0.3)	$1.4	$4.3	$5.6	$5.7	$6.4	$6.9	$7.0	$6.6
School District Revenues	$0.1	$0.5	$0.4	$1.7	$1.8	$2.1	$2.1	$2.2	$2.4
School District Expenditures	1.1	2.2	2.7	4.0	4.0	6.6	6.4	6.4	6.4
Net School District Funds	($1.0)	($1.7)	($2.3)	($2.2)	($2.2)	($4.4)	($4.4)	($4.2)	($4.0)
Community Net Gain (Loss)	($1.3)	($0.3)	$2.1	$3.3	$3.5	$2.0	$2.6	$2.8	$2.6

Table 4-33,Kensington and AJ Mines Cumulative Impacts Fiscal Analysis (Cont'd)

	10	11	12	11	14	15	16	17	18
CBJ Operating Revenues	$10.6	$10.5	$10.0	$9.6	$9.1	$8.0	$7.2	$2.3	$1.5
CBJ Operating Expenditures	4.4	4.4	4.4	4.4	4.4	3.4	2.9	1.0	0.4
Net CBJ Operating Funds	$6.2	$6.1	$5.6	$5.2	$4.7	$4.6	$4.3	$1.3	$1.1
School District Revenues	$2.5	$2.6	$2.8	$3.0	$3.2	$2.5	$2.2	$0.6	$0.1
School District Expenditures	6.5	6.5	6.5	6.5	6.5	5.4	4.8	2.2	1.0
Net School District Funds	($4.0)	($3.8)	($3.7)	($3.5)	($3.3)	($2.8)	($2.6)	($1.6)	($1.0)
Community Net Gain (Loss)	$2.2	$2.3	$2.0	$1.7	$1.5	$1.8	$1.8	($0.3)	$0.1

EFFECTS COMMON TO ALL ACTION ALTERNATIVES

Juneau Traffic

Traffic impacts of the increased Juneau population due to the Kensington Project are assumed to be evenly distributed throughout Juneau according to the current traffic concentrations. The Kensington Project related population would add to the current Egan Drive traffic congestion only to the extent that dependents and support sector workers find jobs with hours similar to those of most workers commuting to the downtown area. Mine workers would add to local traffic only during their days off. Development of the Kensington Project would have a much smaller impact on Egan Drive and downtown traffic than would an equivalent increase in State and federal government employment (The McDowell Group, 1990b).

According to the Alaska Department of Transportation and Public Facilities (ADOTPF, 1989) traffic counts for 1989, the average daily traffic (ADT) along Egan Drive peaks in the Fred Meyer area at 20,739 vehicles. This equates to a maximum peak hour of 2,696 vehicles. Based on the "Highway Capacity Manual" (National Research Council), the capacity for Egan Drive, from the airport to the Douglas Bridge, would be 2,750 vehicles per hour for Service Level B (free flow, minor disruptions easily absorbed) and 3,650 vehicles per hour for Service Level C (minor disruptions cause deterioration of service and formation of lines).

Presently, Egan Drive is at Service Level B. With the U.S. Department of Labor 1989 population and the ADOTPF 1989 traffic count as a baseline and the projected Juneau population with the Kensington Project, Egan Drive peak hour traffic would increase to a maximum level of 3,104 vehicles per hour in 1992. This would change Egan Drive, from the airport to the Douglas Bridge, to Service Level C, an acceptable level of service. Of these 3,104 vehicles per hour, 78 of them (2.5 percent) would be a result of Kensington Project induced changes. From 1992 on, the total traffic volumes would decrease because the total Juneau population is projected to decrease. The change in service level from B to C would occur regardless of Kensington Project impacts. Consequently, the impacts of the Kensington Project on Juneau traffic would be insignificant.

Juneau/Haines Area Traffic

The majority of the Kensington Project workforce would come from Juneau. Residents of Haines, Skagway, and other surrounding communities employed at the Kensington Project would use the existing transportation system, commercial airlines, and Alaska Marine Highway to get to Juneau to meet the company-provided transport to the mine. These non-Juneau residents would be few in number, consequently, their impact on the existing transportation facilities would be insignificant.

During the construction phase, Lynn Canal marine traffic would see an increase. On average, an equipment/supply and a fuel barge would come into the Comet Beach barge landing area approximately once a week (Alaska Pacific Barge, 1990). There are no designated vessel traffic lanes in Lynn Canal. However, the majority of the vessels tend to stay in the middle of Lynn Canal (USCG, 1990). The U.S. Coast Guard does not have any special concerns for safety as a result of increased traffic as long as International Navigational Rules (33 USC 1601-1608) are obeyed (USCG, 1990). The impact of increased traffic in Lynn Canal would be insignificant to the larger vessels (cruise ships, barges, ore ships, etc.). *Figure 2-11, Ferry and Barge Routes*, shows potential shipping routes to the project site.

Comet Beach/Point Sherman Marine Traffic

During the construction phase, a fuel barge and an equipment/supply barge would be expected to average at least three trips per week. Barges typically used in southeast Alaska range up to 250 feet in length by 80 feet in width. The actual size of barges used for the Kensington Project would be dependant on the freight contractor. During operations, traffic would average 0.75 trip per week. These increases in barge traffic can easily be accommodated in Lynn Canal.

There have been some incidents in which the barge supplying fuel to the Kensington mine

exploration activity has interfered with commercial fishing. In these incidents the fuel barge came along the shoreline and did not make radio contact with the fishing fleet to coordinate its approach with the fishermen. These conflicts could be minimized by a perpendicular barge approach into Comet Beach. Radio contact between barge operators and gillnetting boats would also serve to mlnimize conflicts.

The Kensington Venture has begun development of a Memorandum of Agreement (MOA) with the United southeast Alaska Gillnetters to minimize potential conflicts between barge traffic and fishing activities at Sherman Point.

Transport of Hazardous Materials

When transporting hazardous materials there is a potential for an accidental spill. Marine transportation has its own unique circumstances that would Increase the potential and the impacts of a spill over those of land transportation. During winter months, the frequency and severity of the storms in Lynn Canal greatly increase the potential for an accidental spill from a barge sinking, a barge grounding, or a container loss. The impacts could be reduced by: 1) providing adequate onsite storage of required materials so supply barges can wait for a long enough window of good weather to safely deliver the materials; 2) using reliable barge operators that have local knowledge; 3) being prepared for an accident; and 4) transporting the material in accordance with the regulatory agencies.

Hazardous materials include many substances such as fuels, chemical reagents, and explosive components. Hazardous materials transportation is a routine part of shipping on Lynn Canal. Transportation related impacts of shipping hazardous materials to the Kensington Project would be the incremental increased risk of material spills caused by project related traffic. Project related traffic would increase risks in two ways: 1) increase the total quantity of material transported on Lynn Canal and 2) add one material offloading point along Lynn Canal.

Hazardous materials such as fuels, chemical reagents, and explosives would be transported in conformance with U.S. Department of Transportation regulations. The regulations for transporting these materials are found at 46 CFR Subchapter D, 46 CFR Parts 148 and 151, and 49 CFR Parts 173, 176 and 178. These regulations cover package construction, maximum package size, package marking, proper handling, proper storage, fuel barge construction, fuel barge inspection, and fuel barge certification by the U.S. Coast Guard.

Table 2-2, Chemicals and Reagents, lists the primary materials which would be barged to the project site. The explosive, ANFO, would be transported as its separate components, diesel fuel and ammonium nitrate, and mixed onsite as needed.

Most supplies needed for mine operation would be purchased from vendors in the lower 48 states; some materials would be purchased locally. Shipments from the lower 48 states would be transported from the manufacturer to a commercial freight dock in Seattle. Supplies would be consolidated for barge shipment to Alaska in accordance with U.S. Department of Transportation (DOT) shipping regulations.

The freight company would sort supplies into isolation container lots in compliance with U.S. Coast Guard regulations, specifying the compatibility of the various substances. Isolation containers are custom made steel containers designed for transportation of specific substances. Individual supplies would be in sealed units inside the isolation containers. Most often, a container would hold only one type of supply. Specific U.S. Coast Guard and manufacturers' practices dictate that containers with cyanide not be loaded at the edge of the barge.

The Kensington Venture has an agreement with a cyanide producer to provide specially built containers that are designed to float and contain a telemetry tracking device. In case of accidental loss of a container, these precautions would facilitate finding the container.

When possible, as dictated by construction requirements and deliveries, charter tows would be arranged for a dedicated service direct from

Seattle to the Kensington Project site. If project cargo Is not sufficient for a barge load, it would be shipped on regularly scheduled service barges to Juneau, off loaded and subsequently put on a smaller barge, and towed to the Kensington Project site.

Conditions for shipping through Lynn Canal, particularly during winter, can become unfavorable due to high winds associated with tidal currents, and posing a greater risk of an oil transfer accident in the canal during that season. Fuel deliveries would be attempted only during periods of favorable conditions. The Kensington Venture has indicated that fuel would only be off-loaded during periods when waves are less than 3 feet high. (*See Appendix A, Applicant Proposal*). The greater potential for an accident during winter is somewhat ameliorated by this operating constraint and by the relatively light traffic during that season, *Table 4-34, Average Monthly Vessel Traffic in Lynn Canal*, thereby reducing chance for collision. Environmental conditions for shipping are more favorable during summer when traffic in the canal is considered moderate to heavy by the Coast Guard (USCG, 1990).

Table 4-34, Average Monthly Vessel Traffic in Lynn Canal

Type of Vessel	Trips per Month
Winter	
Alaska State ferries	8 to 20
Fuel barges/tanks	8 to 12
Freight barges	8
Foreign freight ships	8
Summer	
Alaska State ferries	8 to 28
Cruise ships	90 to 210
Fuel barges/tankers	2 to 5
Freight barges	8
Foreign freight ships	2 to 3
Fishing vessels	200 or more
Pleasure crafts	200 or more

Source: U.S. Coast Guard, 1991

EFFECTS OF ALTERNATIVE B

Employee Transport

Employees would be transported to the mine from the Juneau Airport via helicopter. One helicopter (S-58T or similar), with a 15 to 20 passenger capacity, would be used for employee transport. The crew rotation schedule would require approximately 600 round trips per year. Based on the information available at this time, this would mean an average of 12 round trips per week, 3 on Monday and Friday and 2 on Tuesday, Wednesday, and Thursday year round. The flight path from the Juneau Airport to the project site would be consistent with FAA regulations and is shown on *Figure 2-13, Helicopter Flight Path*. However, deviations from this flight path could occur if safety of the aircraft, passengers, and crew so dictate.

The additional air traffic would impact local air carriers and the Juneau Airport. Presently Juneau's airport handles about 120,000 operations (take-offs and landings) annually including about 7,000 jet and 75,000 air taxi operations with private aircraft and military operations accounting for the remainder (The McDowell Group, 1990a). The 600 additional operations from the Kensington Project would be an increase of less than 1 percent. The volume of passenger traffic through Juneau International Airport would increase by a total of about 16,000 passengers annually. The airport now handles 180,000 jet carrier passengers each year and an undetermined number of air taxi passengers. Airport revenues currently meet or exceed operating costs (The McDowell Group, 1990a). The additional passenger traffic and operations resulting from the regular transport of Kensington employees to and from the project would not adversely impact the Juneau Airport.

Regularly scheduled commuter airlines serving Juneau, Haines, and Skagway fly over the Kensington site. Based on the summer schedules of these commuter airlines, there are 77 daily flights in each direction over the site. Five days a week there would be at least two helicopter flights to the Kensington heliport. This equates to about a 5 percent increase in regular air traffic between Juneau and the mine. This slight increase in air traffic would not cause

the commuter airlines to alter their operation. Therefore, the impacts to these airlines would be insignificant.

Proper maintenance and operation would insure the reliability of helicopters for employee transport to the mine. The potential for inflight collisions during good weather is considered low due to the low increase in air traffic for the Kensington mine. FAA regulations allow helicopters to fly in conditions that are below those of fixed-wing aircraft. Thus inflight collisions during poor weather would be minimal because other aircraft should not be flying.

There is a potential for a helicopter accident due to pressure to fly during minimal conditions in order to meet crew change schedules and other obligations. This pressure should be minimal because the helicopters would be used exclusively for the Kensington mine. Consequently, the aircraft would be ready to go when the weather breaks and obligations unrelated to the mine operation would not be present. The potential for a helicopter accident is felt to be no greater than any other mode of transportation to the Kensington mine.

Alternative B would impact the vehicular traffic in the vicinity of the Juneau Airport. The helicopter would carry 15 to 20 workers to and from the mine for each 1 hour round trip. This would total 56 people going to and from the airport in a 2-hour period. Assuming that each worker is picked up or dropped off at the airport by a spouse or friend (because of airport parking fees), the 56 workers would generate 112 additional vehicles to the airport in the 2-hour period, or an average of 56 vehicles per hour, assuming a worst case condition with no car pooling. From the 1989 ADOTPF traffic count, the peak hourly traffic on Egan Drive at the airport is 2,353 vehicles per hour. The 56 vehicles per hour to the airport for the Kensington Project would be a 2.3 percent increase in traffic at the airport, assuming the peak hourly traffic occurs at the same time as the helicopter flights to the mine. Consequently, the impacts to the Juneau Airport traffic would be insignificant.

Airport parking is not expected to be significantly impacted by the Kensington Project due to the parking fees required. However, a limited number of project related vehicles would probably use airport parking on an infrequent basis and would primarily consist of consultants and/or project management personnel.

Material Transport

Materials, equipment, and fuel would be transported to the Kensington Project area by barge to a landing site at Comet Beach. This mode of transportation would be used during the construction and operation phases of the project. The impacts during the construction phase were addressed under Impacts Common to All Action Alternatives.

During the operation phase, approximately 600 tons of freight, 75,000 gallons of diesel fuel, and 1,000,000 gallons of LPG fuel would be shipped the site monthly. The site would provide adequate fuel storage and supply storage for two to three months. This would require, on the average, one freight barge, one diesel fuel barge, and one LPG fuel barge per month to the site. During the commercial fishing season the impacts of this barge traffic in the vicinity of Point Sherman could impact the commercial gillnet fishery if measures are not taken to minimize conflicts between fisherman and barge operators. During the operation phase the Kensington Venture would have more control over barge scheduling than during the construction phase. Barges would be scheduled into the site during the non-fishing days and would be requested to approach the shoreline in a perpendicular fashion from the middle of Lynn Canal. The Kensington Venture would cooperate with the southeast Alaska Gillnetters and other Lynn Canal users to establish an optimum schedule for all parties.

During the summer months there are 159 north bound and 159 south bound regularly scheduled vessels (cruise ships, tour boats, freight barges, fuel barges, container ships, and ore ships) passing the Kensington Project each month. The three additional barges per month for the Kensington Project would amount to a 2 percent increase in Lynn Canal summer traffic. The impact of this increase on the summer Lynn Canal traffic would be insignificant. During the winter the number of regularly scheduled vessels drops to nine north bound and nine south bound vessels. The Kensington Project

would cause a 25 percent increase in Lynn Canal winter traffic. While this is a significant increase the impact would be minimal because the total number of vessels would be small. The Coast Guard has not indicated any concern regarding vessel safety due to an increase in vessel traffic that would occur due to this project (USCG, 1990).

A study was performed to address the availability and adequacy of existing barge operators and port facilities at Juneau, Seattle, Vancouver, and Portland (The McDowell Group, 1990a). This study concluded that the existing facilities would be adequate for the Kensington Project and additional facilities would not be needed. The impacts of this project on existing port facilities would be insignificant.

EFFECTS OF ALTERNATIVE C

Employee Transport

Transportation of employees to the project would be by ferry from Auke Bay to a new marine terminal at Slate Creek Cove in Berners Bay. (*See Figure 2-11, Ferry and Barge Routes*). A bus would take the workers from the Slate Creek Cove marine terminal to the mine. The crew rotation schedule would require approximately 416 trips per year with two trips on Monday and Friday and one trip on Tuesday, Wednesday, Thursday, and Saturday year round. The impacts to the Lynn Canal commercial marine traffic would be insignificant because the Kensington Project ferries would not be traveling in the middle of Lynn Canal with the majority of the commercial marine traffic. The marine terminal in Slate Creek Cove would be constructed for the Kensington Project. There is no regularly scheduled commercial marine traffic in Berners Bay, consequently, the impacts on commercial marine transportation would be insignificant. Berners Bay is used by recreational boaters. The impacts of this alternative to the recreational use of Berners Bay is discussed in *Recreation, Chapter 4*.

The traffic on Glacier Highway at Auke Bay would be impacted by the additional traffic caused by mine workers being dropped off and picked up at the ferry terminal in Auke Bay. From the 1989 ADOTPF traffic counts, the average daily traffic on Glacier Highway in the ferry terminal area is 4,056 vehicles per day. On the days which require two ferry trips, a total of 76 mine workers would pass through the ferry terminal over a 6-hour period (assuming trips would be made back to back with no breaks between trips). Assuming the workers would be dropped off by a spouse or a friend, this would result in 152 vehicles over the day. This amounts to an increase to the average daily traffic of 3.6 percent. The impacts of this traffic increase would be insignificant.

Material Transport

During the construction phase, material, equipment, and fuel would be transported to the site by barge to the barge landing site at Comet Beach. The impacts during this phase were discussed under Impacts Common to All Action Alternatives.

During the operation phase, materials and fuel would be barged to a marine terminal in Slate Creek Cove in Berners Bay. The marine transportation in Lynn Canal, the Juneau port facilities, and the marine transportation in Berners Bay would be impacted under this alternative. The impacts to the marine transportation in Lynn Canal and Juneau port facilities were determined to be insignificant. These impacts were discussed in Impacts of Alternative B. Berners Bay is used by recreation boaters. The barge traffic would impact this use. *(See Recreation, Chapter 4)*

EFFECTS OF ALTERNATIVE D

Employee Transport

This alternative includes transporting project employees, via helicopter, from a location between Yankee and Bridget Coves. Yankee and Bridget Coves are located about 3 miles apart past the north end of the pavement on Glacier Highway. It is assumed that a suitable site can be found for the heliport. All sites have similar attributes insofar as they would alleviate potential parking or traffic impacts at the Juneau Airport and would eliminate project related helicopter noise impacts to homeowners and recreationists between the airport and the selected site.

The analysis assumes that workers would travel in individual vehicles to the heliport (worst case). Vehicular traffic will primarily impact the major routes (Egan Drive and Glacier Highway). Since workers will be transported to and from the project by helicopter, the vehicles would be in groups of 15 to 20 with the groups spaced approximately one hour apart. This could generate an additional 40 vehicles per hour on the Glacier Highway during shift change.

Some members of the public expressed concern about traffic in Auke Bay and suggested that busing be considered. The EIS has analyzed individual vehicles as a worst case. If selected, and if traffic were to become problem, busing or car pooling could be added at a later date.

Material Transport

This alternative would have no additional impacts on transportation beyond those described for Alternative B.

EFFECTS OF ALTERNATIVE E

This alternative would cause no additional impacts on transportation beyond those described for Alternative B.

EFFECTS OF ALTERNATIVE F

Alternative F would have the same effect as described for Alternative B.

CUMULATIVE EFFECTS

The analysis of potential cumulative transportation impacts are based on the Kensington Project, the proposed AJ Project, and the potential Jualin Project.

Juneau Traffic

The locations of the Kensington and AJ Projects indicate that the majority of project traffic would follow different routes, therefore the cumulative impact of both projects would be minor.

If the Jualin Project becomes operational, the cumulative impact to traffic volume on select routes would be increased.

Marine Traffic

The proposed AJ Project would have a marine terminal so the cumulative impacts of this project and the Kensington Project would be insignificant.

The development of the Jualin Project, while the Kensington Project is in operation, could double the increase in Lynn Canal traffic, from 2 to 4 percent in the summer and from 25 to 50 percent in the winter (assuming the Jualin mine is the same size as the Kensington). Ferry traffic in Berners Bay could also double if the Jualin project would use a ferry transport system for employees. The impacts on summer traffic would be minor. The percent of increase in winter traffic is significant but the numbers of vessels is still relatively small so the impacts would be minor.

Air Traffic

Since the AJ Project does not rely on air transportation the cumulative effects of the AJ and the Kensington Projects would not be significant.

If the Jualin Mine would use helicopters for transporting employees to the mine, the cumulative effects could be double those of the Kensington Project. This is assuming the worse case of an identical crew rotation schedule for the two mines. The existing Juneau Airport facilities are presently adequate for this worse case situation.

SUMMARY

All the alternatives, except the No Action Alternative, would have some impact on Juneau traffic, airport facilities, air traffic, port facilities, marine traffic, recreation, marine life, wildlife, and commercial fishing. All the impacts of transportation systems would be minor or insignificant. There is the potential for conflicts between barge traffic in Lynn Canal and the gillnet fishery at Point Sherman. The potential impacts on the Point Sherman gillnet fishery would be mitigated by proper scheduling and coordination between fishing and shipping operations.

SUBSISTENCE

This section describes the potential effects of the project alternatives on subsistence resources and activities.

EFFECTS OF THE NO ACTION ALTERNATIVE

Subsistence resources would remain unchanged under the No Action Alternative. Exploration under existing permits could continue. These land based activities with minimal size crews would have little, if any, impact to subsistence resources. Since no traditional subsistence use practices are documented for the existing exploration areas, there should be no impact to subsistence practices.

EFFECTS COMMON TO ALL ACTION ALTERNATIVES

The Forest Service has established guidelines to be used in the evaluation of proposed activity impacts to subsistence resources. These guidelines are outlined in the Subsistence Management and Use Handbook and are as follows:

> "Evaluate the expected effect of the proposed action(s) on subsistence uses and needs. This evaluation shall, as a minimum, address whether or not there is likely to be a reduction in subsistence uses due to:"
>
> - "Factors such as direct impacts on the resource, adverse impacts on habitat, or increased competition for the resources."
> - "Changes in availability of fish and wildlife resources caused by an alteration in migration or location."
> - "Limitations on the access to harvestable resources, such as by physical or legal barriers."

The Kensington Project area is located within the boundaries of the City and Borough of Juneau (CBJ). Juneau is not classified as a subsistence community, therefore hunting and fishing activities by CBJ residents are considered sport or personal use activities and are regulated by the ADF&G.

Berners Bay apparently received little subsistence use in the recent past because of its proximity to the urban center of Juneau, because traditional villages in the area have been abandoned, and because the particular area where the Kensington mine is located lies between the traditional lands of the Chilkat-Chilkoot kwaans and the Auke kwaan (Hall, 1991). No subsistence communities have documented modern subsistence use of terrestrial resources from the project area. There are no records of customary users of land mammals from the Berners Bay area although the area once contained coastal village sites of the Auk' Tlingit (ADF&G, 1991). Some trapping of small furbearers still occurs around Berners Bay, but harvest figures are low and it is not clear whether these animals are taken under subsistence premises (ADF&G, 1991).

Communities such as Klukwan, Haines and Skagway harvest marine resources north of Pt. Sherman, although specific subsistence use in the immediate project area is not documented (USDA Forest Service, 1991b). However any direct effects to the migratory marine resources as a result of the project may indirectly affect these resources since they may be harvested by subsistence users elsewhere (See Aquatic Resources - Marine, Chapter 4, FEIS). It is highly unlikely that any direct adverse effects to subsistence resources would result from operational components of the project alternatives.

Other indirect effects to distant subsistence users are expected to be minor. The Kensington Project has the potential to increase the population of the City and Borough of Juneau by approximately 5 percent (See Socioeconomics, Chapter 4). The projected population increase has the potential for increased sport fishing and hunting in the vicinity of the project area (Kensington Venture would prohibit hunting by employees on the project area) and in other areas traditionally hunted by Juneau residents.

Competition for subsistence resources is a result of various factors such as fish and game

regulations, Federal Subsistence Board (FSB) Regulations, mobility, the natural distribution of game across Tongass National Forest Lands, decreases in resource populations as a result of habitat reductions, decreases in resource populations as a result of overharvest, and access provided to all rural communities in the form of roads, Alaska Marine Highway System and commercial air carriers. These factors and the fact that the majority of the population (Juneau and Ketchikan residents) residing in non-rural designated communities, result in competition for the more abundant wildlife and fisheries resources around rural areas (USDA Forest Service, 1991b).

Deer account for a significant amount (approximately 21 percent) of the edible pounds of subsistence resources harvested by southeast Alaska communities (ADF&G, 1991). Indirect cumulative impacts are likely to have greater effects on deer than on other subsistence resources (USDA Forest Service, 1991b).

The ADF&G has recommended a harvest limit at 10 percent of habitat capability. This recommendation is somewhat controversial. It has been suggested that a 20 percent harvest would accomplish the same deer herd management goals. Review and analysis of the 1989 deer harvest data indicates that there is overharvest on 36 of the 59 (61 percent) WAAs used by CBJ/non-subsistence hunters, based on the currently recommended 10 percent harvest limit. Of the 36 WAAs overharvested, 26 are important to subsistence users.

Subsistence users were the primary cause of overharvest in 16 of the WAAs, CBJ/non-subsistence usage was the primary cause of overharvest on 5 WAAs which are important to subsistence users and there were 7 WAAs overharvested as a result of combined subsistence and non-subsistence usage. Applying a 5 percent harvest increase to individual WAAs does not indicate any change in 1989 WAA status (James, 1991). If the analysis reflects a 20 percent harvest limit, then 21 of the 59 (35 percent) WAAs used by CBJ/non-subsistence hunters experienced overharvesting.

Further review of the data shows that significant un-used harvest capacity exists in other WAAs. Keeping the above items in mind, it seems reasonable to assume that a 5 percent increase in non-subsistence hunting will not effect subsistence users.

If habitat reduction, severe winter conditions and/or continued overharvesting is experienced, it would be expected that deer harvest limits would be restricted by ADF&G and/or the FSB. Any harvest restrictions are expected to affect only non-subsistence hunters.

CUMULATIVE EFFECTS

Cumulative indirect effects to subsistence resource users could result from increased competition from non-subsistence users due to a projected 5 percent increase in population directly related to the Kensington project (See Socioeconomics, Chapter 4, FEIS) combined with an expected 6 percent AJ project population increase (BLM, 1991). Any effects from the predicted combined population increase would be expected to result from competition for subsistence resources, primarily deer. An 11 percent increase to the 1989 deer harvest records for CBJ/non-subsistence hunters does not indicate any material change to the reported 1989 WAA deer harvests. Using this indicator, no additional effects to subsistence resources would be expected.

SUMMARY

It is unlikely that any adverse effects would occur to subsistence resources or practices. The status of subsistence statutes and regulations is not clear. Under previous statutes and regulations the area was not classified as a subsistence area. Subsistence practices for the immediate mine area are not documented. Secondary effects to migratory marine species are not expected. Sport hunting and fishing, to the extent these recreational practices are permitted at the proposed project area, may increase competition for resources with subsistence users elsewhere.

LAND USE/RECLAMATION

The LUD II designation of the Kensington Project area allows for mineral development but emphasizes maintaining wildland character. Thus, approval of any of the alternatives, including the No Action Alternative, would not significantly affect land use or land use planning on the Tongass National Forest.

Some alternatives would affect certain permitted uses of the area differently. For instance, approval of an action alternative would result in changes in appearance of the area. Reclamation efforts would be conducted in a manner to achieve the least amount of impact. The impact mentioned here is described under *Visual Resources, Chapter 4*.

While use of the land would change, those changes are anticipated under the LUD II management direction.

EFFECTS OF THE NO ACTION ALTERNATIVE

Selection of the No Action Alternative would require reclamation of 15 acres. Due to the limited amount of area disturbed, the effort required to achieve final reclamation would be minimal when compared to the other action alternatives. The existing disturbance components are:

- Portal areas including waste rock storage area and water impoundments
- Access Road
- Beach Facilities (Camp)

EFFECTS COMMON TO ALL ACTION ALTERNATIVES

The amount of interim reclamation conducted during the life of the project and the degree of success of final reclamation would ultimately determine the level of impact to the environmental resources of the project area. The primary differences between action alternatives are the amount of land disturbance and the method and location of tailings disposal. Long-term loss of old-growth forest and possibly some long-term wetland loss would occur with each action alternative.

Reclamation objectives for all of the action alternatives would be to return disturbed areas to a stabilized and productive condition and to protect and maintain long-term land and water resources in the area. Development of a detailed and comprehensive reclamation plan based on these objectives and the reclamation goals detailed in Chapter 2, along with strict adherence to the plan, would minimize long-term impacts to land use.

At the time of final and permanent mine closure, a number of reclamation steps would occur. They include the following:

- Removal of structures and facilities
- Portal closure and sealing
- Recontouring and regrading
- Cover material and soil replacement
- Soil sampling and fertilization
- Permanent revegetation
- Mulching (as required)
- Reclamation management and monitoring

A more detailed discussion of these steps is contained in Chapter 2.

Preliminary evaluations of disturbed sites in the Kensington Project area indicate that revegetation can be successfully accomplished at the time of project closure. Revegetation test plots would be established during the operational years of the mine to determine the most appropriate methods and vegetation species to be used for final reclamation.

EFFECTS OF ALTERNATIVES B AND F

Alternatives B and F would disturb and require reclamation of 275 to 277 acres. Reclamation of the initial starter dam face and each subsequent raise would be initiated as soon as each raise was completed. Rapid establishment of vegetation on the dam face would assist stability, reduce erosion, and minimize visual impacts.

Revegetation of the wet tailings surface would not commence until the end of the mine life. During the operating life of the mine a series of revegetation test pilot studies would be

implemented on representative tailings material to establish the most efficient and beneficial method to reclaim the surface of the tailings material. Final reclamation of the Sherman Creek tailings impoundment would require construction and stabilization of permanent stream channels across the tailings area. Upper Sherman and Ophir creeks would be reconstructed across the tailings impoundment and routed around the north end of the dam and down to Sherman Creek via a concrete lined spillway. All channels and the spillway would be designed to contain the PMF.

The reconstructed drainage channels across the tailings impoundment surface would be contained within a channel lined with an impermeable geotextile fabric. The entire channel would be armored with riprap to prevent channel scour and erosion. Overbank flood flow containment for extreme precipitation events would be provided and the entire tailings area reclaimed with appropriate reclamation and revegetation methods. Long-term maintenance would require inspection of erosion protection measures, revegetation, and diversion channels.

The concrete lined spillway structure and the reconstructed stream channels across the tailings would require a long-term bond or some similar guarantee to ensure maintenance and long-term stability of the structure. Where structures like a tailings impoundment may require long-term or indefinite maintenance, the Forest Service would establish substantial bonding requirements to ensure that long-term commitments for inspection and maintenance are met.

EFFECTS OF ALTERNATIVE C

Alternative C would disturb and require reclamation of 392 acres. This alternative is similar to Alternative B except for an additional 8.5 miles of access road and a marine facility at Berners Bay. Also, the portion of the diverted stream channel routing water back into Sherman Creek below the dam would be lined with riprap. Long term maintenance and stabilization concerns would be similar to those for the concrete channel in Alternative B, but, in the long-term, the riprapped channel would appear more natural and be more susceptible to eventual natural stabilization by vegetation.

EFFECTS OF ALTERNATIVE D

Alternative D would disturb and require reclamation of 229 acres. Final reclamation of the Sweeny Creek tailings would require construction and stabilization of a permanent stream channel across the tailings areas. The portion of the diverted stream channel routing water back into Sweeny Creek below the dam would be lined with riprap. Long term maintenance and stabilization concerns would be similar to those for the concrete channel in Alternative B, but, in the long-term, the riprapped channel would appear more natural and be more susceptible to eventual natural stabilization by vegetation.

EFFECTS OF ALTERNATIVE E

Alternative E would disturb and require reclamation of 242 acres (with Site A) or 237 acres (with Site B). Reclamation of the face of the tailings structure would be initiated after each lift is completed, which would aid in stability, minimizing erosion, and reducing visual impacts. Due to the characteristics and configuration of the final dewatered tailings structure, it is unlikely that wetland habitats could be reestablished at this disturbance site. Therefore, a long-term loss of wetland would be expected with this alternative.

CUMULATIVE EFFECTS

There are no anticipated cumulative impacts to land use if appropriate reclamation measures are implemented. The primary impacts would occur at the beginning of the project during initial disturbance and over time would lessen due to reclamation and revegetation. However, long-term maintenance of permanent diversions and reconstructed stream channels associated with Alternatives B, C, D, and F could be necessary to reduce long-term impacts to surface water quality and stream habitat.

SUMMARY

Development of a comprehensive reclamation plan and strict adherence to the plan would reduce the potential for long-term impacts to the environmental resources of the area. The degree of impact would be a function of acreage disturbed and the rate of revegetation

success. The tailings structures would require specific reclamation programs in order to maintain structural integrity into the future.

NOISE

Noise impacts were assessed using standard industrial noise attenuation models. The models account for effects of terrain, vegetation, background noise and noise source and location.

NOISE ASSESSMENT METHODS

Seven noise receptor sites were selected based on activity locations and potentially affected resources. Noise receptor locations are shown on *Figure 4-11, Representative Noise Receptors*. Receptors 1, 2, and 3 represent known areas of mountain goat habitat north of the processing area. Receptor 4 represents a known black bear den near the lower mine portal. Receptor 5 represents a potential mountain goat movement area. Receptors 6 and 7 represent potential recreational areas within Berners Bay near the proposed Slate Creek Cove marine terminal facility (Alternative C).

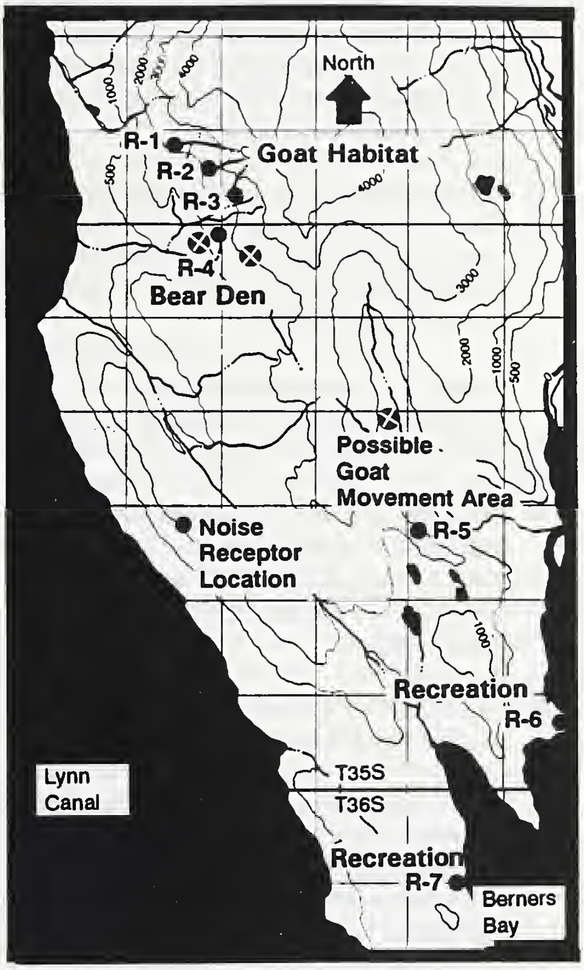

Figure 4-11, Representative Noise Receptors

Assumed Noise Sources

The noise assessment methods and the locations of representative noise sources were developed for each of the action alternatives (Hart Crowser, 1991). Individual noise sources were categorized as either continuous sources, such the operating mill and power plant, or as intermittent sources such as construction of the tailings dam and marine terminal operations. Each individual noise source was assigned a location within the project area and a source sound pressure level (in dBA at a 50-foot reference distance). The source sound pressure levels were derived from literature values or from manufacturers' noise data (Hart Crowser, 1991).

Decibels, expressed as dBA, are simply defined as: a unit for expressing the relative intensity of sounds on a scale from 0, for the average least perceptible sound, to about 130, for the average human pain threshold. The following list of representative common noise levels presents a simplified method for comparison of the predicted noise levels of proposed project activities.

- 35 dBA Assumed background, calm forest
- 36 dBA Barely detectable above background
- 40 dBA Quiet home
- 45 dBA Average home
- 50 dBA Normal conversation
- 55 dBA Average office
- 60 dBA Noisy home

Noise Propagation Modeling

The NOISECALC computer model (Driscoll, 1985) was used to assess noise levels (in dBA) at each of the receptor locations. Key assumptions made for the noise modeling were as follows.

- All of the Intermittent sources were assumed to occur simultaneously. This assumption results in conservatively high calculated noise levels. The calculated noise levels were dominated by the tailings dam construction noise (Hart Crowser, 1991).

- The background noise level at all receptors was assumed to be 35 dBA, which represents coniferous forest with light wind according to published guidance (USDA Forest Service, 1980).

- Receptor 2 was separated from the processing area by a ridge line that is 350 feet higher than the line of sight.

- Receptors 6 and 7 at Berners Bay were separated from the proposed Berners Bay marine terminal by ridge lines that are 160 and 220 feet, respectively, higher than the line of sight.

- With the exception of the Berners Bay marine terminal, all of the noise sources were assumed to be separated from the receptors by coniferous forest for a distance of at least 350 feet. A source attenuation of 14 dBA was assigned to each of those sources in accordance with published guidance (USDA Forest Service, 1980).

- Atmospheric attenuation was based on standard conditions (60 degrees F, sea level elevation, and 70 percent humidity) with no wind.

- It was assumed that the power plant would be constructed with the turbine air inlets and the cooling towers on the west side of the tall turbine building. This would shield the closest noise receptors (R3 and R4) from those noise sources.

EFFECTS OF THE NO ACTION ALTERNATIVE

Mineral exploration could continue under the existing permits. The exploration noises, such as drilling, would be intermittent and are not expected to be as loud as the noises caused by the action alternatives (e.g., tailings dam construction). It is expected that the intermittent noises caused by exploration would be less audible in the mountain goat habitat than would the noises caused by the action alternatives.

EFFECTS COMMON TO ALL ACTION ALTERNATIVES

Helicopter Noise Impacts

Helicopter flights between the upper portal and lower portal areas would create audible noise levels along a corridor about 3 miles wide. The noise levels created around the helicopter flight path were calculated as follows:

- A helicopter was assumed to fly at 2,000 feet elevation along the Sherman Creek valley drainage. The assumed level was 102 dBA at 50 feet away from the helicopter (USDA Forest Service, 1980).

- The NOISECALC model was used to estimate ground-level noise levels along the corridor parallel to the flight path (See *Figure 4-12, Helicopter Noise Receptor Locations and Noise Levels*).

Figure 4-12, Helicopter Noise Receptor Locations and Noise Levels, shows the calculated helicopter noise levels at various points within the cross section of the Sherman Creek valley. The noise level at 500 foot elevation (directly under the flight path) would be 72 dBA, which is about the same noise level as a vacuum cleaner. The noise level in mountain goat habitat at Receptor 5 (same as R-2 in *Figure 4-11, Representative Noise Receptors*) would be 47-52 dBA, which is about the noise level created by a normal conversation. The overall width of the 45 dBA noise level contour is about 18,000 feet.

Impacts of Construction Blasting

Blasting would be done once per day at the rock borrow areas only during the initial construction phases for the tailings dam in Alternative B, C, D, and F. The blasts would produce a short-term noise that would last for several seconds and be similar in sound level to a thunderclap. However, blasts would be carefully controlled through a blasting plan which would be developed by the Applicant as a part of the operations plan. This plan would minimize noise levels to the extent possible.

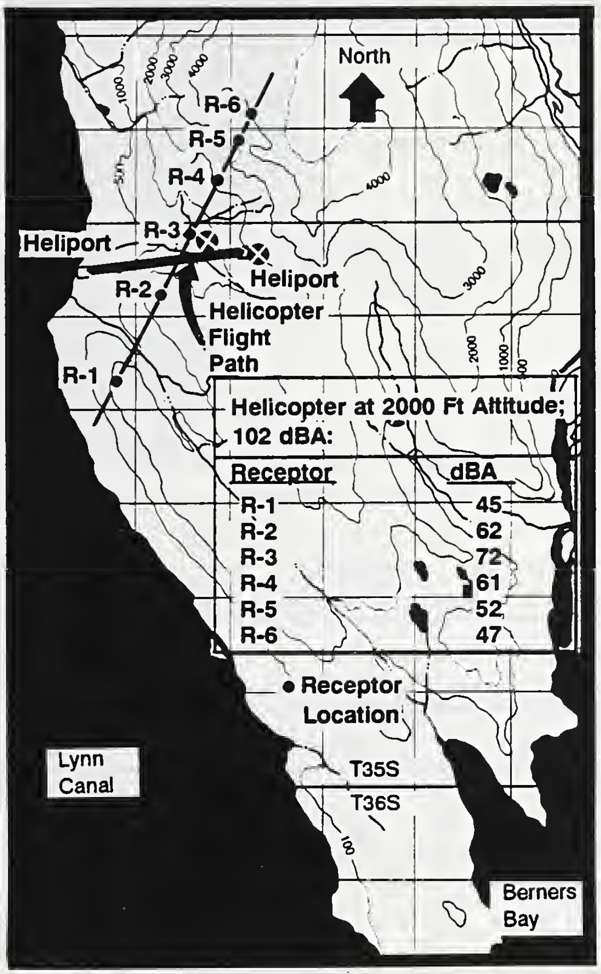

Figure 4-12, Helicopter Noise Receptor Locations and Noise Levels

Modeling of large scale blasting at the proposed Quartz Hill mine near Ketchikan showed that the blast noise level 3 miles from the blast site would be about 65 dBA (about the same noise level created by an air conditioning unit). Since the extent of blasting at the proposed Kensington Mine would be much smaller than the blasting at the Quartz Hill mine, the noise impacts are also expected to be less significant.

EFFECTS OF ALTERNATIVE B

Impacts of Project Area Noise Sources

Table 4-35, Assumed Source Noise Levels - Action Alternatives, lists the source noise levels that were used for this assessment. The assumed locations for each noise source are shown on *Figure 4-13, Noise Source Locations - Alternatives B and F.* The loudest source would be the intermittent tailings dam construction operations which would include waste rock dumping, spreading, and compacting. Helicopter use of the heliport would be the next loudest. The continuous noise sources (above ground mill and combustion turbine power plant) are expected to be minor compared to the intermittent sources.

Calculated Impacts

As shown in *Table 4-36, Comparison of Projected Noise Levels*, the calculated noise levels caused by the continuous sources (mill and power plant combustion turbines) are less than the assumed background value at all receptor sites. The continuous sources would, therefore, probably not be audible at any of the receptors. However, the calculated intermittent noise levels caused by the intermittent noise sources exceed the background at Receptors 1, 2, 3, and 4 near the processing area. The intermittent noises (primarily the tailings dam construction that would occur about every 2 hours for several minutes at a time) would probably be audible at the mountain goat and bear receptor sites north of the project area. The intermittent noises would cause the noise level to increase from 35 dBA (quiet forest) to about 55 dBA (the sound level in an average office). The calculated noise levels at Berners Bay do not exceed the assumed background. Therefore, none of the noise sources are expected to be audible at Berners Bay.

Impacts of Additional Traffic

The additional marine traffic and aircraft flights contributed by Alternative B are not expected to add significantly to the large volume of existing traffic around Lynn Canal and Berners Bay. Therefore, the additional traffic is not expected to significantly increase noise levels in the vicinity. The existing amount of marine traffic and aircraft overflights is much greater than the incremental increases that would be contributed by Alternative B. (*See Table 4-37, Increased Traffic Resulting From Project Alternatives*).

Table 4-35, Assumed Source Noise Levels - Action Alternatives[1]

Source Name	Operations	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
Continuous Sources						
Mill	Milling Operation[2]	72	72	72	72	72
Turbines	Three 3,000 KW Gas Turbine Generators	79	79	79	79	79
Dry Tailings Disposal	2 Bulldozers; 2 Haul trucks, 1 Vibratory compactor				120	
Tailings Hauling	1 Haul truck along road from mill to disposal area				105	
Intermittent Sources						
Dam Construction	2 Bulldozers; 2 Haul trucks, 1 Vibratory compactor	120	120	120		120
Refuse	Unloading at incinerator	85	85	85	85	85
Comet Beach Terminal	Tug; barge unloading; truck loading	96	96	96	96	96
Berners Bay Terminal	Tug, barge unloading, truck loading		96			
Heliport	Helicopter[1]	102	102	102	102	102
Truck 1	Haul truck along access road to processing site	94	94	94	94	94
Truck 2	Haul truck going to tailings dam site	105	105	105		105
Truck 3	Haul truck near Berners Bay Terminal		94			

[1] All figures in dBA at 50 feet from noise source

[2] Physical noise level measurement (Mohr, 1991) at McCoy Cove operation (sag mill and 2 ball mills)

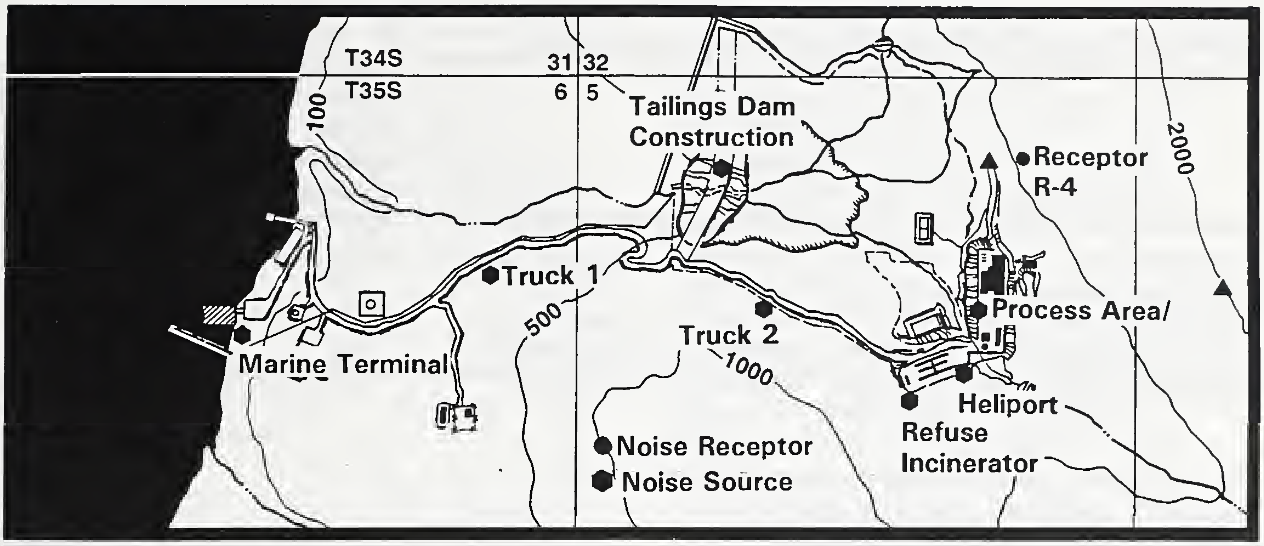

Figure 4-13, Noise Source Locations - Alternatives B and F

Table 4-36, Comparison of Projected Noise Levels (Noise Levels are in dBA)

	PROJECT ALTERNATIVE				
	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
RECEPTOR 1 (GOAT HABITAT)					
Background	35	35	35	35	35
Continuous	30	30	30	56	30
Intermittent	55	55	41	56	55
RECEPTOR 2 (GOAT HABITAT)					
Background	35	35	35	35	35
Continuous	21	21	21	57	21
Intermittent	56	56	42	57	56
RECEPTOR 3 (GOAT HABITAT)					
Background	35	35	35	35	35
Continuous	12	12	12	57	12
Intermittent	56	56	44	57	56
RECEPTOR 4 (BEAR DEN)					
Background	35	35	35	35	35
Continuous	29	29	29	28	29
Intermittent	56	56	49	19	56
RECEPTOR 5 (GOAT					
MOVEMENT)	35	35	35	35	35
Background	28	28	28	28	28
Continuous	20	20	20	19	20
Intermittent					
RECEPTOR 6 (BERNERS BAY)	35	35	35	35	35
Background	< 10	< 10	< 10	< 10	< 10
Continuous	< 10	20	< 10	< 10	< 10
Intermittent					
RECEPTOR 7 (BERNERS BAY)	35	35	35	35	35
Background	< 10	< 10	< 10	< 10	< 10
Continuous	< 10	21	< 10	< 10	< 10
Intermittent					

Table 4-37, Increased Traffic Resulting from Project Alternatives

Traffic Type	Existing Volume	Units	Proposed Project Additional Volume	New Total Volume
Cruise Ships	56	Trips/Month	0	56
Passenger Ferries/Tour Boats	36	Trips/Month	32*	68
Freight Ships and Barges	9	Trips/Month	3	12
Small Aircraft and Helicopters	2,310	Flights/Month	96	2,406

* Berner's Bay Access Alternative Only

Helicopter flights to and from the Juneau airport would result in additional noise impacts to houses, trails and other areas along the proposed primary route from the airport through Montana Creek. One to four round trips could be expected each day during the week. The Kensington Venture has stated that flights would be expected only on week days and only during daylight hours.

In cloudy weather with low ceilings, the helicopters would travel along the coast at an altitude determined by safe flying needs. Noise impacts could be expected to users of Bridget Point State Park and to coastal residences when this flight path is used.

EFFECTS OF ALTERNATIVE C

Source levels for this alternative are listed in *Table 4-35, Assumed Source Noise Levels - Action Alternatives.* The noise impacts of this alternative are expected to be similar to those described for Alternative B. *Table 4-36, Comparison of Predicted Noise Levels*, lists the calculated noise levels at each of the receptors. The locations for each noise source are shown on *Figure 4-14, Noise Source Locations - Alternative C.* The intermittent noise sources at the Berners Bay terminal are calculated to be significantly attenuated by the high ridges north and south of the terminal location, and the calculated noise levels at Receptors 6 and 7 at Berners Bay are less than the assumed background. The marine terminal noises would, therefore, not be audible outside of Berners Bay.

Negligible impacts of helicopter traffic would be expected under this alternative.

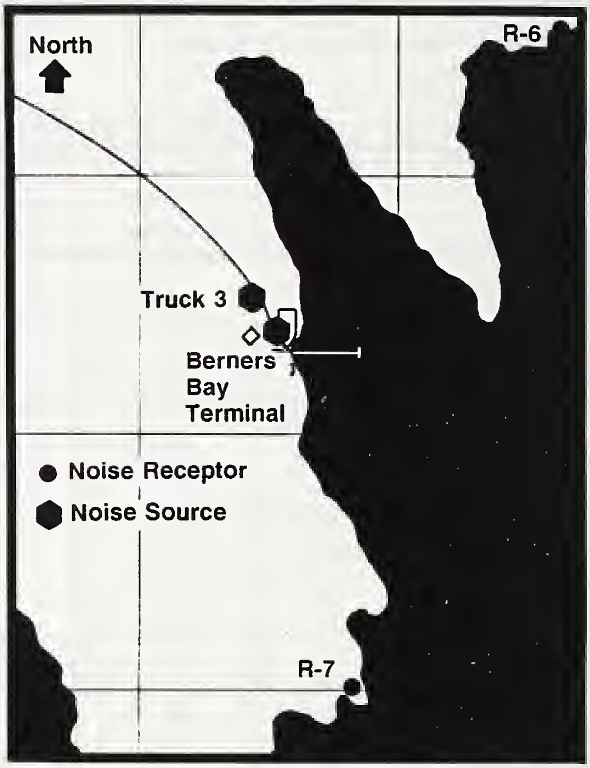

Figure 4-14, Noise Source Locations - Alternative C

EFFECTS OF ALTERNATIVE D

Source levels for this alternative are listed in *Table 4-35, Assumed Source Noise Levels - Action Alternatives.* The noise impacts for this alternative are expected to be less significant than Alternatives B and C, because the intermittent construction operations at the Sweeney Creek tailings dam are farther from the goat habitat receptors. *Table 4-36, Comparison of Predicted Noise Levels*, lists the calculated

noise levels at each receptor. The locations for each noise source are shown on *Figure 4-15, Noise Source Locations - Alternative D.* The calculated maximum noise level for this alternative (at the bear den habitat Receptor 4) is 49 dBA. For this alternative, the continuous noises from the mill and power plant would not be audible at the wildlife receptor sites.

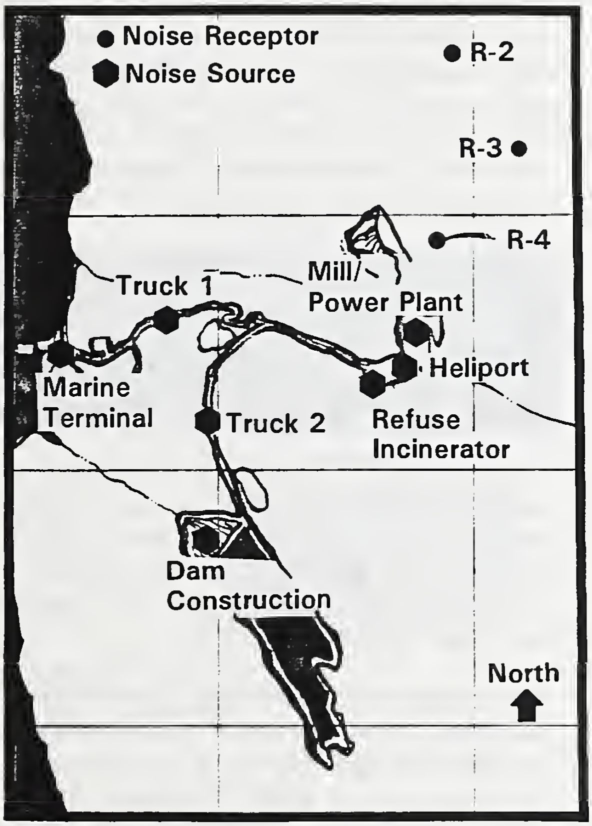

Figure 4-15, Noise Source Locations - Alternative D

This alternative would eliminate helicopter noise impacts near the Juneau airport. Impacts to Point Bridget State Park would be greatest because helicopters would be climbing or descending near the park.

EFFECTS OF ALTERNATIVE E

Source levels for this alternative are given in *Table 4-35, Assumed Source Noise Levels - Action Alternatives*. The noise impacts of this alternative are expected to be more significant than for Alternatives B, C, D, and F. Continuous hauling, dumping, and compaction of the dewatered tailings would create ongoing noises that would be audible at the mountain goat receptor sites north of the project area. The tailings operations would occur about eight times per hour for several minutes at a time. The noises caused by the dewatered tailings operations would be more discontinuous, and hence more distracting, than the steady noise caused by the mill and power plant. *Table 4-36, Comparison of Predicted Noise Levels*, lists the calculated noise levels at each receptor. The locations for each noise source are shown on *Figure 4-16, Noise Source Locations - Alternative E*. For this analysis the dewatered tailings operations were modeled as a "Continuous Source". The continuous sources (Site A) would be audible at the mountain goat and bear receptor sites (1-4). The continuous sources at Site B would not be as audible due to the additional distance from the receptors. None of the sources would be audible at the Berners Bay receptor sites.

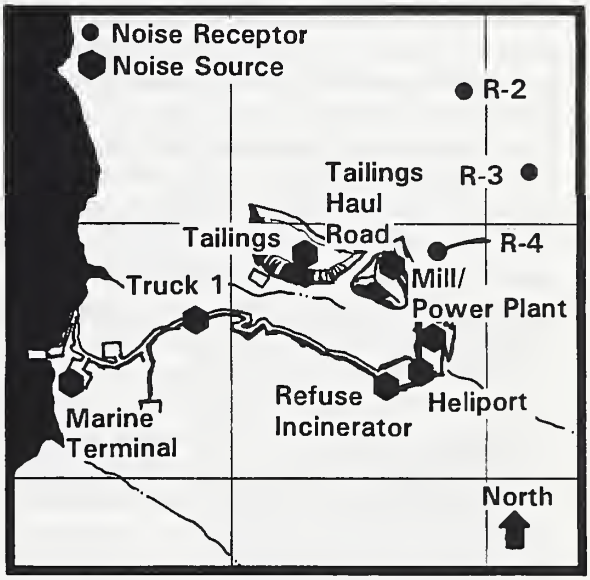

Figure 4-16, Noise Source Locations - Alternative E

Helicopter noise impacts would be the same as described under Alternative B.

EFFECTS OF ALTERNATIVE F

Alternative F would have the same effects as Alternative B.

CUMULATIVE EFFECTS

If the Jualin Project were to begin actual mining operations, then it is possible that the noises would be barely audible at Berners Bay. The Jualin Project is several miles from Berners Bay and the surrounding vegetation consists of dense forest, so any noises created by that project would be attenuated before reaching Berners Bay. Construction and operation of an additional marine terminal in Slate Creek Cove for a Jualin operation could increase the potential for increased noise levels at Berners Bay receptor sites.

It is unlikely that noise caused by the Jualin Project would be audible at the Kensington Project, because the two operations are separated by a high ridge and over 1 mile of dense forest.

SUMMARY

Noises caused by each of the project alternatives would include continuous noise from steady sources such as the mill and power plant and short-term intermittent sources such as waste rock dumping and spreading at the tailings disposal dam. The continuous noise from the mill and power plant can be economically controlled. Calculated mill and power plant noise levels in nearby mountain goat and bear habitat are less than the assumed background value, and it is unlikely that the mill and power plant would be audible. However, the short-term noises caused by the intermittent sources (e.g., tailings dam construction, helicopter flights) were modeled to be audible in the surrounding wildlife habitat. (*See Wildlife, Chapter 4*). None of the project noises associated with the action alternatives would be audible at receptor sites in Berners Bay. (*See Recreation Resources, Chapter 4*).

The noise impacts caused by Alternative C were modeled to be similar to Alternative B. Noises from the Berners Bay terminal were modeled to be readily attenuated by the ridge lines surrounding the terminal location.
The noise impacts caused by Alternative D (Sweeney Creek Tailings Dam) would be less significant in the wildlife habitat north of the project site, because the loudest noise source (tailings dam construction) would be farther from those habitat areas.

The noise impacts caused by Alternative E (Site A) were modeled to be the most significant of any of the project alternatives. The semi-continuous dewatered tailings dumping, spreading, and compaction operations were modeled to be audible in the surrounding wildlife habitat. None of the noises would be audible at Berners Bay.

Noise caused by additional marine traffic and aircraft overflights would probably have no significant effect on wildlife or recreationists because the incremental increase in traffic resulting from the Kensington Project would be small compared to the existing traffic volumes.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

An irreversible commitment of resources is defined as the loss of future options. It applies primarily to non-renewable resources, such as minerals or cultural resources, and to those factors which are renewable only over long time spans, such as soil productivity.

Irretrievable commitments apply to the loss of production, harvest or use of renewable natural resources. For example, some or all timber production from an area is irretrievably lost while an area serves as a winter sports site. The production lost is irretrievable, but the action is not irreversible. In the winter sports site example, if the use changes, it is possible to resume timber production. *Table 4-38, Commitment of Resources*, summarizes irreversible and irretrievable impacts for the environmental resources evaluated for all alternatives.

Table 4-38, Commitment of Resources

Air Quality	
Alternative A	No foreseeable or predicted irreversible or irretrievable commitments. Project would comply with Alaska State Implementation plan and ADEC air quality regulations.
All Action Alternatives	Same as Alternative A.
Geology	
Alternative A	Minor irreversible and irretrievable impacts due to waste rock and ore removed during exploration activity.
All Action Alternatives	Irreversible and irretrievable commitments by mining approximately 20 million tons of ore and 1.2 million tons of waste rock. The precious metals would be committed to the market. The resultant tailings and waste rock have no use in the foreseeable future.
Surface Water Hydrology	
Alternative A	No foreseeable or predicted irreversible or irretrievable impacts.
All Action Alternatives	Project development would be required to comply with all applicable State and Federal water quality regulations. No foreseeable or predicted irreversible or irretrievable impacts.
Groundwater Hydrology	
Alternative A	No foreseeable or predicted irreversible or irretrievable impacts.

Table 4-38, Commitment of Resources (Cont'd)

Groundwater Hydrology cont'd	
All Action Alternatives	Project development would be required to comply with all applicable State and Federal water quality regulations. No foreseeable or predicted irreversible or irretrievable impacts.
Marine Aquatics	
Alternative A	No foreseeable or predicted irreversible or irretrievable impacts.
Alternative B	Minor irretrievable losses of intertidal habitats and organisms associated with Comet Beach terminal.
Alternative C	Minor irretrievable losses of estuarine habitat and organisms associated with Slate Creek Cove Terminal.
Alternative D	Same as Alternative B.
Alternative E	Same as Alternative B.
Alternative F	Same as Alternative B.
Fresh Water Aquatics	
Alternative A	No foreseeable or predicted irreversible or irretrievable impacts.
Alternative B	Irretrievable loss of aquatic organisms in diverted portions of Sherman and Ophir creeks. Irreversible loss of Ophir and Sherman creek habitats which would not be reconstructed.
Alternative C	Same as Alternative B.

Table 4-38, Commitment of Resources (Cont'd)

Fresh Water Aquatics cont'd	
Alternative D	Irretrievable loss of aquatic organisms in diverted portions of Sweeny Creek. Irreversible loss of Sweeny Creek habitats which would not be reconstructed.
Alternative E	No foreseeable or predicted irreversible or irretrievable impacts.
Alternative F	Same as Alternative B.
Soils/Vegetation/Wetlands	
Alternative A	The current 15 acre disturbance has minor irretrievable commitments on timber resources and irreversible commitments to minor acreage of soil and wetland productivity.
Alternative B	Irreversible commitment of 164.9 acres of old- growth forest. Irretrievable commitment of 275 acres of soil productivity, of which 231.3 acres are classified as wetlands. Six populations of western paper birch (proposed for listing under the Alaska natural heritage program) would be irretrievably lost by development of the tailings impoundment.

Table 4-38, Commitment of Resources (Cont'd)

Soils/Vegetation/Wetlands cont'd	
Alternative C	Irreversible commitment of 183.4 acres of old-growth forest. Irretrievable commitment on 392 acres of soil productivity, of which 240.8 acres are classified as wetlands. Potential irreversible loss, in addition to losses shown for Alternative B, of western paper birch population due to construction of Berners Bay access road.
Alternative D	Irreversible commitment of 181.4 acres of old-growth forest. Irretrievable commitment of 229 acres of soil productivity, of which 220.6 are classified as wetlands.
Alternative E	Irreversible commitment of 144 acres old-growth forest (site A) or 140.3 acres old-growth forest (site B). Irretrievable commitment of 242 acres (site A) or 287 acres (site B) of soil productivity, of which 209 acres are classified as wetlands.
Alternative F	Same as Alternative B, except 277 acres would be disturbed
Wildlife	
Alternative A	Irretrievable losses due to short-term habitat loss on the existing 15 acres of disturbance.

Table 4-38, Commitment of Resources (Cont'd)

Wildlife cont'd	
Alternative B	Irretrievable short and long-term habitat losses would occur on 275 acres of disturbance. Potential Irretrievable reductions in black bear and mountain goat populations. There would be no anticipated irreversible commitments.
Alternative C	Irretrievable short and long-term habitat losses would occur on 392 acres of disturbance, including estuarine habitats in Slate Creek Cove. Potential irretrievable reductions in black bear and mountain goat populations due to habitat loss and noise effects.
Alternative D	Irretrievable short and long-term habitat losses would occur on 229 acres of disturbance. Potential irretrievable reductions in black bear and mountain goat populations due to habitat loss and noise effects. There would be no anticipated irreversible commitments.
Alternative E	Irretrievable short and long-term habitat losses would occur on 242 acres (Site A) or 237 acres (Site B) of disturbance. Potential irretrievable reductions in black bear and mountain goat populations. Potential irreversible loss of wetlands habitat due to dewatered tailings structure.
Alternative F	Same as Alternative B, except 277 acres would be disturbed.

Table 4-38, Commitment of Resources (Cont'd)

Recreation	
Alternative A	There are no foreseeable irreversible or irretrievable commitments.
Alternative B	Same as Alternative A.
Alternative C	Same as Alternative A.
Alternative D	Irretrievable reduction in undeveloped recreational opportunities in Berners Bay.
Alternative E	Same as Alternative A.
Alternative F	Same as Alternative A.
Cultural Resources	
Alternative A	There are no irreversible or Irretrievable commitments to identified resources.
Alternative B	Same as Alternative A.
Alternative C	Potential irreversible and irretrievable commitment of one identified cultural site in Slate Creek Cove
Alternative D	Same as Alternative A.
Alternative E	Same as Alternative A.
Alternative F	Same as Alternative A.
Visual Resources	
Alternative A	Minor irretrievable commitments due to exploration disturbance.

Table 4-38, Commitment of Resources (Cont'd)

Visual Resources cont'd	
Alternative B	Irretrievable and irreversible commitments would occur in the form of form, line, color, and texture contrast of a tailings structure constructed across Sherman Creek. Reclamation and natural succession of vegetation would be expected to eventually mitigate most long-term visual impacts.
Alternative C	Same as Alternative B, with the addition of an access road from the operations facilities to Berners Bay and a marine terminal in Slate Creek Cove.
Alternative D	Same as Alternative B, except tailings impoundment would be constructed across Sweeny Creek.
Alternative E	Same as Alternative B, except the dewatered tailings structure would alter the landscape.
Alternative F	Same as Alternative B.
Socioeconomics	
Alternative A	No irreversible or irretrievable commitments have been identified.
All Action Alternatives	There would be an irretrievable decrease in housing availability during project construction. There would also be other irretrievable reductions in the quality of life in Juneau due to Population increases and resultant stress on public services.

Table 4-38, Commitment of Resources (Cont'd)

Subsistence	
Alternative A	No irretrievable or irreversible commitments have been identified.
All Action Alternatives	Same as Alternative A.
Land Use	
Alternative A	Wildland character of Sherman Creek Basin would be recovered through reclamation.
Alternative B	Wildland character of Sherman Creek Basin would be irretrievably altered during mine operation. This change would be reversed following reclamation.
Alternative C	As described for Alternative B plus irretrievable alteration of Berners Bay during mine operations.
Alternative D	As described for Alternative B plus irretrievable alteration of Sweeny Creek from tailings during mine operation.
Alternative E	Same as Alternative B.
Alternative F	Same as Alternative B
Noise	
Alternative A	Current noise sources would be removed upon reclamation.
All Action Alternatives	No irreversible or irretrievable commitments have been identified beyond those discussed under other resources such as wildlife and noise.

CHAPTER FIVE

LIST OF PREPARERS

INTRODUCTION

The EIS for the Kensington Gold Project was prepared by ACZ Inc. as a third-party contractor for the Forest Service. ACZ Inc. has responsibility for completion of the EIS under the direction of the Forest Service and has utilized several subcontractors in the preparation of this EIS. The Forest Service was responsible for review and acceptance of the EIS. The following are lists of individuals on the Forest Service ID Team and ACZ's ID Team who were directly involved in the effort.

LIST OF PREPARERS

A number of technically qualified individuals have participated in the preparation of this EIS. Individuals with experience in Alaska and with mining and its environmental effects have contributed to this document.

Conrad Parrish, ACZ Inc. - Principal-in-Charge. B.S. in Mining Engineering from Colorado School of Mines. MBA University of Phoenix 14 years experience in mining operations and environmental aspects of mining activities in Western North America, including Alaska.

Michael Phelan, Cedar Creek Associates, Inc. - Project Manager and Wildlife Biologist. B.A. in Zoology from the University of California with postgraduate studies in biology and ecology from San Diego State University. 16 years experience in wildlife students.

Jay James, ACZ Inc. - Assistant Project Manager. B.A. in Geology from Western State College. 21 years experience in mining geology, mining operations, and regulatory aspects of mining.

Lawrence Moulton, MJM Research - Fisheries Biologist. B.S., M.S. and PhD in Fisheries Biology from the University of Washington. 19 years of experience in north Pacific fisheries investigation and over 11 years of experience in Alaska fisheries studies.

Lawrence Lestelle, MJM Research - Fisheries Biologist. B.S. and M.S. Fisheries, University of Washington. Field studies experience has ranged from the Washington State coast to Arctic coast. 18 years experience salmonid ecology, effects of habitat alterations, population dynamics and fisheries management.

Ed Cryer, James M. Montgomery Consulting Engineers, Inc. - Waste Water Treatment. B.S in Biological Science - California State University, Hayward, CA; M.S.,Environmental Biology - California State University, Hayward, CA; M.S., Civil Engineer - California State University, Hayward, CA. 19 years experience in environmental engineering, water quality management and process design.

Tom Kessler, Kessler and Associates - Oceanography. B.Sc. in Biology from the University of Alberta; Ph.D. in Oceanography from the University of British Columbia. Over 18 years experience in oceanography, fisheries management problems and the mining industry. Oceanography related expertise in marine ecology, hydrodynamics, mathematics and computer science.

Alan Krause, ACZ Inc. - Geologic Engineer. B.S. in Geology from Pacific Lutheran University, M.S. in Engineering Geology from Mackay School of Mines. 10 years experience in geotechnical aspects of mining operations with 7 years Alaska experience.

Vladimir Straskraba, Hydro-Geo Consultants, Inc. - Hydrogeologist. B.S. and M.S. in Engineering Geology, Czechoslovakia School of Mines. 30 years experience in surface and groundwater studies for mining operations.

Janet Shangraw, Hydro-Geo Consultants, Inc. - Hydrogeologist. B.S. degree in Watershed Science/Hydrology from Colorado State University. 10 years of experience in hydrologic investigations.

Patrick Burden, Northern Economics - Economist. B.S. in Business Administration from Portland State University and M.S. in Economic Geography from Portland State University. 10 years experience in evaluating socioeconomic impacts of industrial facilities, municipal expansions and government projects in Alaska.

Mary G. McGown, Beck & Baird Associates - Visual and Recreation Resources. B.A. degree from University of Northern Colorado and MLA in Landscape Architecture from University of Colorado at Denver. Graduate studies in recreation and social ecology at the University of Idaho. 9 years experience in visual resource assessment, recreation planning, design and research.

Kent A. Crofts, IME - Vegetation, Wetlands, Soils, Reclamation. B.S. and M.S. in Range Science from the University of Utah. 15 years experience with environmental and reclamation aspects of mining.

Jack Lobdell, Lobdell & Associates - Cultural Resources. B.A. in History/Anthropology from University of New Mexico, M.A. in Anthropology from University of Wyoming, PhD in Bioarchaeology from University of Tennessee. 19 years experience in cultural resource investigations and academic research with special emphasis on Alaska.

Clifford Cole, TRC Consultants - Air Quality. B.S. and M.E. in Mechanical Engineering from Cornell University. 17 years experience in technical air quality assessment work and regulatory aspects of air quality.

William Craine, James M. Montgomery Consulting Engineers, Inc. - Transportation. B.S. Civil Engineering, University of Akron. 20 years experience with transportation, sewer, water, coastal stabilization and marine facilities in Alaska.

James Wilder, Hart Crowser, Inc. - Noise. B.S. Civil Engineering, University of California, M.S. Civil Engineering, University of Washington. 10 years experience in assessment, licensing design and construction of industrial facilities in the Pacific Northwest and Alaska.

Melissa Blackmer - Word Processing.

USDA FOREST SERVICE

The following individuals are members of the Forest Service ID Team. They contributed to the EIS by assisting in the scoping process and by providing review and input throughout development of the document.

Roger Birk - EIS Team Leader. B.S. in Natural Resource Management from Lincoln University, Missouri. 13 years experience with the Forest Service and Bureau of Land Management.

Paul Bradford - Economics. B.S. in Natural Resource Management from Ohio State University, M.S. in Forest Management from Oregon State University. 13 years experience with the Forest Service.

Linda Christian - Recreation. B.S. in Forestry from Humboldt State University, California 15 years experience with the Forest Service and private industry.

Stan Davis - Cultural Resources. B.A. and M.A. in Archeology/Anthropology from the University of Northern Colorado. 20 years experience with the Forest Service and private industry.

Judi Falk - Wildlife. B.S. In Biology from Central Michigan University. M.S. in Wildlife Management from Virginia Polytechnical Institute and State University. 10 years experience with the Forest Service and National Park Service.

John Kato - Geology/Minerals. B.A. In Geology and B.S. In Geological Oceanography from California State University/Humboldt. 16 years experience with the Forest Service and Bureau of Land Management.

Don Martin - Fisheries. B.S. in Wildlife Management from the University of Idaho, M.S. In Fisheries Resources from the University of Alaska, Fairbanks. 2 years experience with the Forest Service.

Michael Martin - Economics. B.A. in Economics from University of California, Santa Barbara. M.S. in Economics from University of Oregon, Ph.D In Economics from University of Oregon. 11 years experience with Forest Service, Bureau of Land Management, and United Nations.

Dom Monaco - Visuals. B.S. in Landscape Architecture from Penn State University. 19 years experience with the Forest Service, Corps of Engineers, and private industry.

Kathleen Morse - Economics. B.S. in Natural Resource Economics from Montana State University. Graduate Study in Coastal Zone Management at University of Washington. 4 years experience with the Forest Service and private industry.

Margaret Beilharz - Hydrologist. B.S. in Freshwater Ecosystems 1977 from Huxley College, Western Washington State University. 14 years forest management experience with 8 years focused on hydrologic issues.

Steve Paustian - Hydrology. B.S. In Watershed Management from Colorado State University M.S. in Forest Hydrology from Oregon State University. 13 years experience with the Forest Service.

Dennis Rogers - NEPA Coordinator. B.S. and M.S. in Geology from Kent State University, Ohio. 18 years experience with the Forest Service and private industry.

Betty Wilt - Geotechnical Engineer. B.S. in Geological Engineering from the Colorado School of Mines. 4 years experience with the Forest Service and U.S. Geological Survey.

FOREST SERVICE U S DEPARTMENT OF AGRICULTURE

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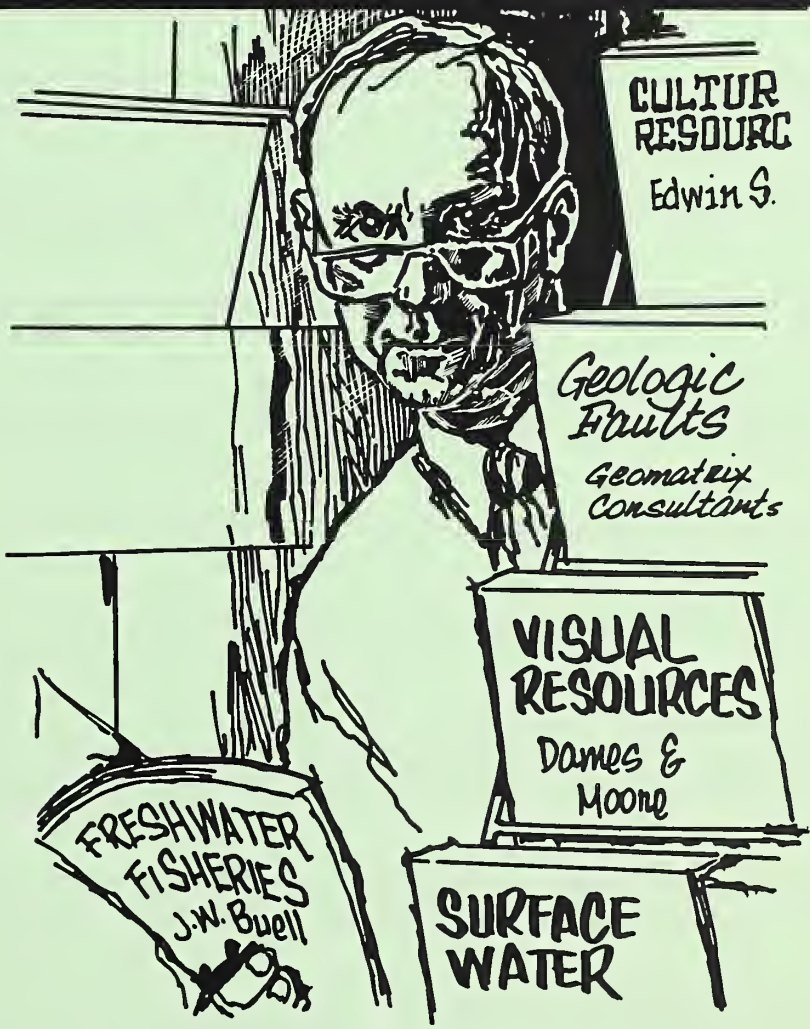

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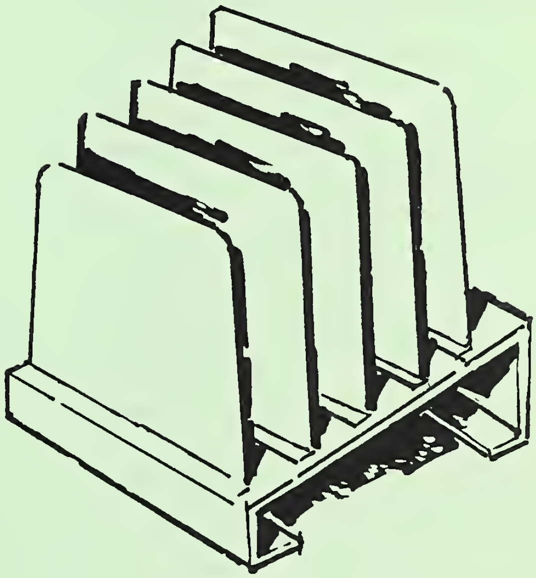

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Juneau Ranger District
8465 Old Dairy Road
Juneau, Alaska 99801
(907) 586-8800

Priority Mail